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UNLOCKING LEARNING SPACES

AN EXAMINATION OF THE INTERPLAY BETWEEN THE DESIGN OF LEARNING SPACES AND PEDAGOGICAL PRACTICES

Industrial PhD Thesis by Bodil Bøjer

Rune Fjord Studio & The Royal Danish Academy of Fine Arts, Schools of Architecture, Design and Conservation

Bodil Bøjer

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Learning Spaces and Pedagogical Practices

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Industrial PhD Thesis

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Schools of Architecture, Design and Conservation

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ABSTRACT

In recent years, many schools are being built or rebuilt aiming to support new pedagogies that will foster the development of 21st century skills. These pedagogical visions are often materialized in new typologies of learning environments with a more open, flexible and activity-based interior design. The layout of these new spaces demands new teaching and learning strategies in order to become supportive tools for practice, which is often assumed to occur automatically following the alteration of the spatial design. However, as both research and practice reveal, changing a space does not necessarily change practice, which is why many schools end up with a discrepancy between the spatial design and their pedagogical practices. So how can we assure a better alignment between the design of a learning space and the practices in the space?

This PhD thesis addresses the challenges of designing new learning spaces where the spatial design and pedagogical practices align. The point of departure for the thesis is the assumption that the relationship between learning space design and pedagogical practice is a constant and dynamic interplay, where each part affects the other. This understanding builds on current learning space research with a relationalist perspective and is inspired by Actor Network Theory (ANT).

The particular contribution of this thesis to the research field is that it explores and discusses the interplay between learning space design and pedagogical practice with a specific focus on the design process. The main focal point is the significance and potential of using participatory design processes and methods to inform the relationship between space and practice—both before, during and after the design and implementation of a new learning space. Hence, the thesis contributes to current research as well as current practice in the designing of learning environments for children and youths in primary and secondary schools, while insights also relate to other learning environments in e.g. libraries and universities.

The potential of participatory design processes and tools in aligning learning space design and pedagogical practices is explored in three practice-based design experiments. The methodological approach in these experiments builds on

constructive design research and employs a programmatic approach to design research in which design experiments are the core of the project. Thus, the empirical research has been conducted as three design experiments in two Danish schools, where design processes and design methods have been explored in a participatory context with school management, teachers and students.

Overall, the design experiments examine three designerly ways to influence the interplay between learning space design and pedagogical practice, focusing respectively on the design process, the design tools and the design (prototypes). The findings from the design experiments indicate that the level and extent of stakeholder involvement in the design processes of new learning spaces influence the following alignment of space and practice. However, they also indicate that participatory processes are complicated and difficult to conduct due to many factors such as the participants' professional and cultural backgrounds as well as limitations in building budgets and time schedules. This was found to pose a challenge to the alignment of space and practice in this research project. In response to this, I suggest the concept of 'participatory activation' as a yet unexplored part of a design process, which implies that creators and users of learning spaces collaboratively activate and match space with practice. This process of activation is proposed to succeed the implementation of new or re-built learning spaces.

Furthermore, the thesis explores co-design tools and techniques as a means to unlock learning spaces during 'participatory activation' by supporting the development of teacher environmental awareness and competence and through this help the teachers take control of the physical surroundings and actively work with the alignment of space and practice. The conclusion is that the alignment of space and practice is a dynamic and ongoing collaborative process that needs to be considered and revised iteratively before, during and also after the implementation of a new learning space design. In this process co-design, as a participatory design approach, was found to be a key to unlocking the space-practice relationship.

The thesis is the result of a three-year Industrial PhD project conducted in collaboration with the Danish design company Rune Fjord Studio and The Royal Danish Academy of Fine Arts, Schools of Architecture, Design and Conservation (KADK) in

DANSK RESUMÉ

I de senere år er mange skoler blevet (om-)bygget med det formål at understøtte nye pædagogikker. Pædagogiske visioner om eksempelvis at fremme udviklingen af det 21. århundredes kompetencer er ofte materialiseret i nye typer af læringsmiljøer med et mere åbent, fleksibelt og aktivitetsbaseret interiør, men for at indretningen af disse nye læringsmiljøer skal blive til understøttende redskaber i undervisningen, er der behov for nye undervisnings- og læringsstrategier. Alt for ofte forventes det således at den pædagogiske praksis ændres automatisk som følge af det nye rumdesign, men både forskning og designpraksis viser at et nyt rumdesign ikke nødvendigvis ændrer på praksis. Mange skoler ender derfor med et fysisk læringsmiljø, som ikke stemmer overens med måden hvorpå der undervises og læres. Så hvordan sikrer vi en bedre sammenhæng mellem et læringsrumsdesign og den pædagogiske praksis i rummet?

Denne Ph.d.-afhandling adresserer udfordringerne ved at designe nye læringsrum, hvor det rumlige design og pædagogisk praksis stemmer overens. Udgangspunktet for afhandlingen er den antagelse at forholdet mellem et læringsrumsdesign og pædagogisk praksis er et konstant og dynamisk samspil, hvor begge dele indbyrdes påvirker hinanden. Denne forståelse af rum-praksis forholdet bygger på samtidig forskning i læringsmiljøer med et relationelt perspektiv og er inspireret af aktør-netværksteori (ANT).

Afhandlingens særlige bidrag til forskningsfeltet er, at den undersøger og diskuterer samspillet mellem læringsrumsdesign og pædagogisk praksis med specifikt fokus på designprocessen. Omdrejningspunktet er her betydningen og potentialet af at bruge participatoriske designprocesser og metoder til at påvirke forholdet mellem rum og praksis – både før, under og efter design og implementering af et ny læringsrum. Selv om afhandlingen konkret beskæftiger sig med samtidig forskning og praksis i design af læringsmiljøer for børn og unge i folkeskolen, er indsigterne let generaliserbare og har således også relevans for andre læringsmiljøer på f.eks. biblioteker og universiteter.

I tre praksis-baserede designeksperimenter udforskes og analyseres bruger-inddragende designprocesser og redskabers potentiale som metode til at

afstemme samspillet mellem læringsrumsdesign og pædagogisk praksis. Hvert designeksperimenterne afprøver en 'designerlig' måde at påvirke samspillet mellem læringsrumsdesign og pædagogisk praksis ved at fokusere på henholdsvis designprocessen, designredskaber og designet (prototyper). Den metodologiske tilgang i disse eksperimenter bygger på constructive design research og bruger en programmatisk tilgang, hvor designeksperimenterne er projektets kerne. Det betyder, at de empiriske undersøgelser er udført som tre designeksperimenter i to danske skoler, hvor jeg har undersøgt designprocesser og designmetoder i en brugerinddragende kontekst sammen med skoleledelse, lærere og elever.

Resultaterne fra designeksperimenterne viser at niveau og omfang af brugerinddragelsen i designprocesser af nye læringsmiljøer påvirker den efterfølgende overensstemmelse mellem rum og praksis. De viser også at brugerinddragende processer er komplicerede og vanskelige at udføre på grund af forskellige faktorer såsom deltagernes professionelle og kulturelle baggrunde og begrænsninger i byggebudgetter og tidsplaner. Sidstnævnte viste sig at udgøre en udfordring for tilpasningen af rum og praksis i dette forskningsprojekt. På baggrund af dette foreslår jeg begrebet 'participatorisk aktivering' til at indfange en hidtil overset del af designprocessen, hvor skabere og brugere af læringsrum i fællesskab aktiverer og matcher rum med praksis. Aktiveringsprocessen foreslås at efterfølge implementeringsfasen af nye eller ombyggede læringsrum.

Afhandlingen udforsker og foreslår desuden co-design som en metode i 'participatorisk aktivering' af læringsrum, der kan bruges til at åbne op for det fysiske læringsrum ved at støtte udviklingen af lærernes rumlige opmærksomhed og kompetence. Derved hjælpes lærerne til at tage kontrol over de fysiske omgivelser og aktivt arbejde med at afstemme rum og praksis.

Afhandlingen konkluderer at afstemningen af rum og praksis er en dynamisk og vedvarende kollaborativ proces, som iterativt skal overvejes og revideres før, under og efter implementeringen af et nyt læringsrumsdesign. I den proces kan co-design (som en brugerinddragende designtilgang) være en nøgle til at åbne op for samspillet mellem rum og praksis.

Afhandlingen er resultatet af en treårig erhvervs-Ph.d., som er udført i samarbejde

PREFACE

A research process rarely proceeds on a straightforward path from first inquiry to conclusion but turns and twists as it explores the research inquiry. In that sense, it resembles an expedition, where the researcher sets off to discover an unexplored territory. The path is long and winding as it leads through rough territory, sometimes uphill, sometimes downhill. Sometimes the sun shines, at other times the rain pours and a harsh wind blows in your face. Often you have to make a detour or a side trip and a few times the path leads to a blind alley. Then, finally, the path goes straight to the top of the hill, the sky clears, you reach the vantage point and the world opens up in front of you with a clear view of all its interconnecting parts.

This has also been the path of my research process. Long, winding, uphill, downhill, wrong turns, right turns and finally to the top. It has been a tough but also an amazing journey and I am grateful to all the people who have supported me on the way—sometimes leading me further along the path, at other times helping me get back on track. And none of it would have been possible without 'my crew', who kept the home base running and continuously supported me during the ups and downs.

Numerous people have crossed my path and contributed with input, inspiration, questions, knowledge, hugs and occasional bottles of bubbles during my three years of research. I am immensely thankful to all of you! I am aware of the risk of mentioning some names and not others, but I hope that those of you who are not mentioned by name know that the 'thank you' also includes you.

In particular, I would like to thank...
... my supervisors, Ida Engholm from The Royal Danish Academy (KADK) and Rune Fjord from Rune Fjord Studio, without whom this PhD project would never have happened. Ida, your dedication to and enthusiasm for my research have been exceptional and invaluable. Often, you have been the steady pillar I have sought and leaned on in an, at times, chaotic research process. Your strong and wise guidance on and off the tracks of the PhD jungle, your constructive comments and in-depth questions to my research and your solid and sharp eyes on my writing have all contributed to making this thesis

... my wonderful husband Martin, for the life and the family we share. I deeply appreciate your support and patience throughout this hilly PhD journey and for always trying to make me laugh despite our difference in humour. With you at my side I can do anything. You are my rock, my inspiration and my heart.

Rostorp, September 2019
/Bodil

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1 // UNLOCKING THIS THESIS

The first chapter frames the research project by introducing the motivation, background and context for this research inquiry. It presents the research proposal and research questions, followed by an introduction to the practice-based research approach applied in the project. The chapter also clarifies the research context as an Industrial PhD-project with both an industrial and an academic anchorage and introduces the industrial partner in the project, Rune Fjord Studio. Finally, the chapter presents the scientific theoretical approach, the thesis structure and defines the two main concepts of this thesis— learning space and pedagogical practice.

DOES SPACE CHANGE PRACTICE?

I will start this thesis by claiming that space does not change practice; people do. This, however, does not mean that the layout of a learning space is considered to be immaterial. On the contrary, the design of learning spaces plays an important role in pedagogical practices, but mainly if it is brought into play by its users.

In recent years, many schools are being built or rebuilt aiming to foster the development of 21st century skills in students, such as creativity, communication, critical thinking and collaboration. These skills, in particular creativity, are often claimed to be necessary in order to meet the demands of an ever-changing future (Beghetto & Kaufman, 2014). As regards learning space design, this generally means reduced numbers and/or sizes of classrooms in favour of spacious learning environments with a more open, flexible and activity-based interior. These new types of environments, often denoted by terms like 'open' (Alterator, 2015), 'new generation' (Byers & Imms, 2018) or 'innovative' (Mahat, Bradbeer, Byers, & Imms, 2018), are believed to promote a more personalised kind of learning and, since they offer a variety of workstations and technologies, they support the students in becoming life-long and self-directed learners 'capable of navigating the complexities of a technology-mediated and knowledge-based society' (Byers, Imms, & Hartnell-Young, 2018b, p. 1).

Despite the many new constructions or renovations, there is still a lack of knowledge when it comes to what really works in these new school buildings. As Stephen Heppell (2004) points out, 'No one knows how to prevent 'learning-loss' when you design a room "pedagogically", whereas we know lots about designing for minimum heat loss' (Cited in: Blackmore, Bateman, Loughlin, O'Mara, & Aranda, 2011, p. 38; Higgins, Hall, Wall, Woolner, & McCaughey, 2005, p. 03). Many of the new types of learning environments demand new teaching and learning strategies in order to match the interior with practices. Still, research in learning environments have mainly focused on either pedagogical practice or physical design elements and less on actual relations between the spatial setting and the use. What is more, it is often assumed that changes in pedagogical practices will occur automatically following an alteration of the spatial design (Blackmore et al., 2011). However, as Mulcahy, Cleveland and Aberton (2015) emphasise, there is no strict causal link between a new learning space and pedagogic

change, which means that changing a space does not automatically change practice (Bøjer, 2017; Imms & Byers, 2017). As several researchers point out, including Boys (2011a), Gislason (2018) and Ricken (2010), the way a space is appropriated depends largely on the users and the organisation of the school.

According to Kenn Fisher (2016), more evidence is needed concerning the impact of these new types of learning environments in order to convince teachers to change their pedagogical practice to match the new environments. I would claim that more research is needed not only in regard to what works and why, but also on how to match practice with the new physical settings. In particular the change from traditional classrooms to new flexible learning spaces can be experienced as very difficult as the particular affordances of the new spatial settings demand teaching practices that differ from the traditional teacher-centred approach (Bøjer, 2017). The spatial layouts in innovative types of learning environments do not support a teacher-centralised approach to teaching but require a more learner-centred teaching approach. Still, teachers are often expected to accept the new physical framework and adjust their practices with little or no training and support.

The research presented in this thesis addresses this dilemma by examining the relationship between the design of learning spaces and pedagogical practices through a participatory and practice-based design research lens. The thesis is the finalisation of a three-year research project in learning space design, conducted as an Industrial PhD project and supported by Innovation Fund Denmark. The project was developed in collaboration with the Danish design agency, Rune Fjord Studio, who has specialised in the design of physical learning environments in schools, universities and libraries. Every day, they meet the challenges of designing for and with the users and matching design and practice, which explains their interest in this project. Academically, I have been affiliated with the Institute of Architecture and Design at The Royal Danish Academy of Fine Arts, Schools of Architecture, Design and Conservation (abbreviated KADK).

MOTIVATION & BACKGROUND

Intuitively, we know that the physical environment of the classroom has an impact on the behaviour of both teachers and pupils. The difficulty is understanding how this impact occurs, and how much of this impact is consciously and deliberately planned by the teacher. The knowledge of these relationships can benefit teachers in their awareness of their environment and this knowledge is empowering, enabling teachers to take control of the space and deliberately design it. Any teaching can be effective if teachers understand their setting and how it influences behaviour. Beyond that lies the need to feel capable of responding to this understanding by having a proactive rather than a defeatist attitude towards the setting. (Martin, 2004, p. 77)

Since the end of the 19th century, architects and educationalists have recognised the power of space to influence learning processes, resulting in various experiments in the design of schools to frame and support different pedagogies (Kirkeby, 2006; Melhuish, 2011). Following this, the relationship between the physical learning environment and pedagogical practice has received increased attention in recent years, both in practice, and as a field of research as reported in various studies by e.g. Boys (2011a); Byers, Imms, and Hartnell-Young (2014); Imms and Byers (2017); Imms, Cleveland, and Fisher (2016); Jamieson, Fisher, Gilding, Taylor, and Trevitt (2000); and Kirkeby (2006).

According to Blackmore et al. (2011), research into the connections between learning spaces and pedagogical practices is informed by both contemporary architectural and educational research into what constitutes best design and best practice. However, they claim, there is little empirical research that considers what happens once you are in the space. This is backed up by Willis, Bland, Hughes, & Elliott Burns, who point out that 'there is little known about the experiences of teachers and learners in newly designed learning spaces, and whether the potential for reimagined pedagogies is being realised' (2013). Improved knowledge of the relationship between space and practice can, as Martin (2002) notes in the quote at the beginning of this section, enable teachers to take control of the space and deliberately change it to support their pedagogical practices. This is then believed to lead to improved learning as space and practice support each other.

Hence, this underlines a need for further research into the relationship between learning space design and pedagogical practice. Today, knowledge of the actual nature of the interplay between pedagogies and spatial design is very limited and most spatial design is developed based on assumptions made by developers or designers. Too often schools are built or rebuilt based on a pedagogical vision that has not been converted into practice, resulting in the physical learning environment becoming an obstacle and a means of frustration rather than an asset for the users. Despite an increased focus on the importance of stakeholder involvement in the design process (Koutamanis, Heuer, & Könings, 2017), I still experience the involvement of end users to be fairly limited in school building processes due to different factors such as budgets and the vast number of end users. Furthermore, decision makers and creators of the design often abandon the school building project as soon as the new design has been implemented, which leaves the end users with a learning space design they might not know how to use. According to Koutamis, Heuer and Könings (2017), 'Accommodating teaching and learning activities in school spaces are often limited to re-arranging furniture rather than realising or improving its potential for specific educational conditions' (p. 296). In the worst cases, the physical environment ends up having to be redesigned due to a mismatch with pedagogical practices, which can be a really costly affair. Getting it right from the beginning is therefore critical, which is emphasised by Koutamanis et al. (2017).

With this research project, I hope to contribute to diminishing the gap between vision and practice and advise decision makers, creators and users of learning environments on how to develop and use more appropriately fitting spatial designs and practices. The project questions the way schools are being designed today and explores design processes and design methods as tools for informing the relationship between space and practice. In addition to addressing the need for academic research, this project therefore also addresses a current need for practical knowledge concerning the design and use of learning spaces.

A relational understanding of learning spaces

A basic premise of this thesis is the understanding of the relationship between learning space and pedagogical practice as relational and interdependent, which means that space and practice are regarded as endlessly informing and influencing each other (Boys, 2011a). This implies that space 'shapes' social relationships and practices without determining them (Lefebvre, 1991; Massey, 1994).

The interdependent relationship between space and practice is explored using a practice-based design research approach in three empirical design experiments. In this matter, the thesis operates from a relationalist perspective, thereby following in the footsteps of researchers like Boys (2011a, 2011b), Kirkeby (2006) and Mulcahy, Cleveland and Aberton (2015), who all explore learning spaces in a socio-material perspective. In this perspective, space and practice cannot be separated and neither is to be understood as determining the other if an understanding of the relationship is to be obtained. Mulcahy et al. (2015) explain that:

> *...in a relationalist way of thinking, learning spaces and the uses made of these spaces are created and sustained together; they are in a mutually constitutive relationship. Design can never provide a direct fit between space and occupation, and this space is never simply occupied by people. (Mulcahy et al., 2015, p. 580)*

Furthermore, Mulcahy et al. (2015) claim that little empirical research from a relationalist perspective exists in the emerging field of learning spaces. This thesis aims to address this gap as it explores the relationship between the physical learning space and selected furniture designs and pedagogical practices, using a relationalist point of view. This is done through three design experiments in actual educational settings. The relationalist perspective will be elaborated in chapter 3.

Taking a people-centred approach to the design of learning spaces

My research project is closely connected to the changing landscape of human-centred design research that has influenced a line of new design practices. Since the 1970s a user-centred design approach has been growing, opening up for new design disciplines like service design, interaction design and transformation design (Sanders & Stappers, 2008). This has created a shift from the designing of products to designing for people's purposes, which requires a different approach to the role of both designer and user in the design process. Sanders (2012) calls this a 'people-centered space,' 'where relationships between people matter more than products and where human experience is what matters most of all' (pp. 3-4).

An argument of this thesis is that the shift from designing a product to a purpose also applies to the design of physical learning environments, making the involvement of the end users of the schools in the design process necessary. Even though the overall aim of the educational institutions is the same—to educate the students according to nationally set goals and standards—the pedagogical methods and tools differ widely from school to school. And no user (student nor teacher) is alike and thus cannot be expected to experience, understand and use space in similar ways. The argument of the necessity for participant involvement in the design process is backed up in research by Könings et al. (2014), Woolner (2010) and Higgins, Hall, Woolner and McCaughey (2005) to mention a few.

Therefore, the main focus of this space-practice study is on participatory design processes of new learning environments and participatory design tools and their significance for the alignment of learning space design and pedagogical practices. The project examines both the significance of a participatory design process with stakeholders for matching space and practice and participatory tools as a means for activating the physical learning spaces with the users afterwards. This implies that the study involves stakeholders in different stages of the design process of physical learning environments from pre-design to post-design. The common understanding of *stakeholder* is a person, group or organisation that has an interest or concern in something, in this case the development of the physical learning environment. In the

context of this research project, the term is mostly used with reference to the school management and teachers at the school. Still, stakeholders can also relate to students, parents, contractors and officials from the municipality and in a broader perspective even include other decision makers and politicians.

In particular the post-design phase of learning spaces plays a central role in this research project as this aspect has received little attention in both practice and research up until now. In general, user involvement in the predesign or 'fuzzy front-end', as Sanders and Stappers (2008) call it, of a design process has and does receive a great deal of attention, both in praxis and in research. This is also the case when building new physical learning spaces. But user involvement rarely continues throughout the design process and designs are often implemented without any follow ups or collaborative processes of spatial activation.

This study builds on three design experiments focusing on participatory design processes and participatory design tools conducted in collaboration with the design agency Rune Fjord Studio in actual learning environment settings. The experiments took place at two schools, school A and school B (both primary and secondary schools) in an iterative process where the findings from one experiment led to the next. In 2016, Rune Fjord Studio got the assignment to redesign a common learning space in school A, which gave me the possibility to perform the first design experiment presented in this thesis. The findings from this experiment in combination with my literature research made me realise the significance of stakeholder involvement in the design process as well as the need for more focus on the interaction and connection between space and practice and how to inform this. Subsequently, this led to the development of the following two design experiments.

As the project treats the relationship between learning space design and pedagogical practice with a particular focus on design processes and tools, the project draws on research from the fields of architecture, design and education. The project does not examine the impact of a particular type of learning space or pedagogical practice on educational activities and outcomes, but focuses on the interplay between a given space and a given practice.

In order to limit the scope of the project, I have chosen to focus on learning spaces

for children and youths in public schools, but insights also relate to post-compulsory education and other learning environments in e.g. libraries.

RESEARCH PROPOSAL

Research on learning spaces is a rather well-established field, which the following chapter will elaborate; however, there still exist gaps in current literature concerning the interplay between space and practice. Much research on learning spaces takes place in fields other than design, in particular within the field of education, and it is often mainly conceptual. What is more, research mostly focuses on best design and best practice and less on the actual use of the spaces, as explained earlier. My research project addresses these gaps. It aims to add to current knowledge about the relationship between learning space design and pedagogical practice by exploring the interplay and ways to bridge the gap between spatial design and practice using design methods through a practice-based approach. The focus lies on both participatory design processes and participatory tools. The study takes a practise-based design approach, which means that the research is grounded in both theory and praxis.

The starting point of the research project is the challenges concerning user participation faced by creators and designers of new learning spaces, but it also addresses the challenges emerging once a new spatial design has been put into use. The objective of the project is to bring attention to the significance of the design process, participatory design tools and the physical learning space design in relation to pedagogical practices and the necessity of aligning space and practice. As touched upon earlier, there has been a tendency to assume that changing a space would change practice. However, as current research emphasises, this is not the case. According to researchers like Martin (2002), the appropriation of the space highly depends on the users and their environmental competence, meaning their ability to actively use and redesign their physical environment to fit pedagogical practices. Another influential element in the alignment of learning space and practice is the organisation of the school, which can either support or complicate practice. Therefore, an aim of this project is to create applicable knowledge about the interplay between learning

space design and pedagogical practices that will potentially support decision makers, creators and users in the process of designing and appropriating new learning spaces. This is attempted through an examination of the interplay between space, practice and organisation and the significance of stakeholder involvement in the design process of new learning environments to align these three elements.

Another focus area of this project is the transition into new learning spaces. Participatory processes are often experienced as complicated due to the involvement of stakeholders from different professions and with different objectives and needs. They can even be limited by external factors such as budgets, time schedules and the number of affected stakeholders (i.e. in a school where it can be very difficult and costly to involve all users). This might complicate the alignment of space and practice as not all users are involved in the design process. Therefore, this research project also aims to create applicable knowledge about the activation of new learning space designs following the design process by examining the potential of using co-design tools as a means for activation and alignment of space and practice.

Finally, being an industrial PhD, the purpose of this research project is even to contribute to the praxis at Rune Fjord Studio by providing knowledge on the above-mentioned topics as well as contributing to a design approach based on co-design that can be used in Rune Fjord Studio when designing and implementing new learning spaces.

Research questions

These objectives and focus areas have led to the following key research question:
How can participatory design processes and tools inform the interplay between learning space design and pedagogical practice?

Furthermore, the design experiments performed as part of this research project each have their own subsidiary research question as follows:
Experiment #1: *What is the significance of stakeholder participation in the design process of new learning spaces for the alignment of space and practice?*
Experiment #2: *How can approaches from co-design inform the interplay between pedagogical*

practices and learning space design and the transition into new learning spaces?
Experiment #3: *What is the potential of spatial activation for the alignment of learning space design and pedagogical practices?*

The research questions will be explored through current theory and research as well as through the three practice-based design experiments.

RESEARCH APPROACH

Methodological approach

This research project takes on a practice-based design research approach and is positioned in a *research through design* (e.g. Archer, 1995; Frayling, 1993), *action research* (e.g. Argyris & Schön, 1991; Reason & Bradbury, 2008) and *constructive design research* (e.g. Koskinen, Zimmerman, Binder, Redstrom, & Wensveen, 2011) tradition. This approach has been chosen as it allows me to generate new knowledge through processes that simultaneously develop, test and improve a design or a design process in relation to a specific spatial environment and with a group of stakeholders. In research through design and constructive design research, the research inquiry is investigated from the practitioner's methods and practise is acknowledged as a means of gaining new knowledge. In my project, this means trying out design processes and methods and developing concrete spatial environments in an iterative dialogue with a physical material and users that reflects back on the research. As proposed by Schön (1983), the research reflections are generated *in action* through the design process and concrete design proposals.

As a tool to structure and frame the empirical research, which consists of three design experiments conducted in two schools, I use a programmatic design research framework (Binder & Redström, 2006; Redström, 2017). Binder and Redström (2006) argue that a design researcher has to establish a provisional knowledge regime, a design research program, in order to frame and contextualise her inquiry. The design experiments then relate to the program in a dialectic process as they unfold and either substantiate or challenge the view of the program. The program is also

explained by Binder and Redström (2006) as a hypothetical 'worldview' that makes the particular research inquiry relevant. In this research project, the research programme is concerned with the interplay between the design of learning spaces and pedagogical practices and ways to unlock space in relation to practice, which will be elaborated in chapter 4.

The research of this thesis is conducted using qualitative methods to collect and analyse the data of the three experiments. These methods include both traditional and widely used tools, such as observations and interviews, and designerly tools, such as co-design activities. The methodology and methods, as applied in this research project, will likewise be elaborated in chapter 4.

The many roles of a practice-based design researcher

As an Industrial Researcher in practice-based design research, my roles and assignments in the research project have been multiple. Many times, I have balanced between professional design assignments in Rune Fjord Studio and research activities, trying to combine both in order to create knowledge of both a practical and a theoretical character. In the same manner, I have jumped between 'reflecting-on-action' and 'reflecting-in-action', as defined by Schön (1983), being a researcher, a practitioner and also a design assistant.

In terms of the design experiments, which constitute the core of this research project, my research has included:

- Doing fieldwork
- Co-planning and co-organising before and during the design process at school A
- Co-planning and co-organising before and during co-design workshops at school B
- Co-creating and co-designing spatial designs
- Observing and interviewing participants
- Documenting what happened during the workshops and processes
- Facilitating the workshops
- Analysing, theorising and communicating experiences, insights, issues and challenges.

In practice-based design research, being a part of the research field is a condition for

the researcher. Simultaneously (or alternating), the researcher is deeply involved and intertwined in the field but also has to be able to step aside and reflectively and curiously relate to the field. This is why, according to Archer (1995), it is impossible for a researcher to conduct investigations in an action research project (such as research through design) free from personal interference, judgements and valuation. Being deeply involved in the interventions of the project, the researcher might want to see them succeed.

In my case, being part of both the academic and the commercial world has been a challenge. However I have sought to continuously remind myself of the dilemma and stay aware of my own involvement in the design agency in order not to challenge the integrity of the research project. I will return to this later.

RESEARCH CONTEXT

The industrial anchorage of the project at Rune Fjord Studio

The research project is developed in collaboration with the designers and architects at Rune Fjord Studio whose assignments range broadly from spatial designs in educational institutions, libraries, and offices to individual art projects and co-creation learning projects for children. The company has existed since 2011 and is run by designer and artist Rune Fjord, who has many years of experience designing learning environments prior to the establishment of Rune Fjord Studio.

The focus area of Rune Fjord Studio is to explore how space and spatial design can become a supporting tool for various activities and actions. Over the last few years, Rune Fjord Studio has become increasingly focused on spatial design in learning environments and developed a profound interest in spaces that support multiple learning experiences, for instance innovative learning environments. The company works from a strong belief that the physical environment plays an important role in supporting different activities. At the same time, the company acknowledges the relational interplay between the physical environment and the users of the

environment, where space and use of the space is created and sustained simultaneously. Hence user participation is of great importance in the design processes led by the company.

Rune Fjord Studio has designed many learning environments in primary and secondary schools, libraries and higher educational institutions. The involvement of the users and other stakeholders in the design process to align actual needs, wishes and expectations has always been a starting point for new design projects. Experience shows that old habits are hard to break, which is why a process of change in collaboration with the users is expected to help facilitate the transition from one spatial setting to another. Still, despite intentions of involving all stakeholders in the process when designing new spatial settings, this has proven difficult to realise in many projects as there are often interfering constraints like budget limitations or time pressure. For this reason, Rune Fjord Studio is interested in exploring this topic further, searching for new methods to work with participatory involvement in design development. The company even wants to bring more external attention to the significance of participatory design processes in school building projects and the role of the physical design in practice.

Overall, the PhD project has provided an opportunity to supplement the existing empirical knowledge at Rune Fjord Studio with a theoretical-methodological foundation that hopefully will help the company design better learning environments and become specialists within the field.

Besides Rune Fjord Studio, the Danish furniture company, Højer Møbler A/S, has supported the project. The company was mainly partnering in the empirical work of the research process, as they produced two furniture prototypes and took part in the workshops that were part of the experiments at school B in 2018. The furniture company develops, produces and supplies furniture and interior design solutions to the educational sector.

The academic anchorage at KADK

Besides being anchored at the Design Agency Rune Fjord Studio, this research project is also rooted in the research environment at the Royal Danish Academy of Fine Arts,

Schools of Architecture, Design and Conservation (abbreviated KADK), where there is a strong tradition of research on design methods and design thinking. Formally, I was enrolled at the Institute of Architecture and Design as my project overlaps both fields with its focus on school design and participatory design processes.

At KADK, I have been part of the cross-disciplinary research group Formlab and I have had regular exchanges with fellow PhD students from KADK and other Danish and international research institutions. As the field of learning space design is a new and, until now, unexplored research field at KADK, my research has benefitted from contact with other researchers and research institutions engaged in research on learning space design. It has developed as a result of my engagement with the European research network DRAPES (Design, Research and Practice in Educational Spaces) and our network meetings in Denmark (May 2018), on Iceland (October 2018) and in Sweden (March 2019), as well as my interaction with the ILETC research team from the University of Melbourne with whom I have met on several occasions in Europe and visited for two weeks in Melbourne (Nov-Dec 2018). ILETC has also arranged the conferences Transitions 2017 (London) and Transitions 2018 (Copenhagen), where I presented and got feedback on my research. This proved to be a valuable source of information on research in the field of innovative learning environments and the transition into these as well as a catalyst for contact with fellow peers.

From an academic point of view the thesis is a contribution to the research field of learning space design that draws on research in education, architecture and design. Research within these fields will be elaborated in chapter 2 and 3.

The researcher's background and motivation

The desire to engage in a PhD grew over several years before applying for the grant at Innovation Fund Denmark. I hold an MA in Art History and Aesthetics and Culture from The University of Aarhus (2005) and since 2005, I have been involved in the development of numerous physical learning environments in libraries, schools and universities together with Rune Fjord and his team of designers and architects.

Through this work, my interest and curiosity concerning the relationship between space and pedagogy has been triggered and I have become aware of the possibilities of

using space more actively as a tool to support different learning experiences, as well as the lack of knowledge and research on this subject.

This research project actually set sail with a slightly different perspective, focusing on the relationship between creative learning and the design of the physical learning space. During the first research period of the project, the focus shifted towards pedagogical practices in general and not just practices that were aimed to foster creativity, because I experienced several mismatches between newly designed learning spaces and the way these were inhabited. I have often visited a newly built school and experienced that the intentions behind the design did not match the actual teaching and learning taking place there. This made me wonder why—was it the fault of the design, the designer or the teacher? Or could it be blamed on something else, i.e. a lack of focus on the coherence between design, practice and user involvement in the design process? Subsequently the first experiment was initiated and I set out to examine the relationship between space and practice with a particular focus on the design process. This thesis is the result of this journey.

SCIENTIFIC THEORETICAL APPROACH

Theoretical position

This research project builds on the assumption that not only do people influence their surroundings, the surroundings also influence people and their actions. This is not a cause-effect relationship; rather the relationship between space and practice is understood as a constant and dynamic interplay, where each part affects the other. This is why, in relation to the objective of aligning space and practice, it does not make sense to look separately at practices or spaces.

From an epistemological viewpoint the thesis takes on a social constructivist research perspective, as it explores the relationship between space and practice as a socio-material construction based on Actor-Network Theory (ANT). Inspired by Bruno Latour and his understanding of things and people as equal actors in a network of relationships, where everyone and everything informs and influences the others, I

am interested in the interplay between the spatial designs and the users and how to create a better alignment of space, practice and the organisation of the school through participatory processes and tools. From this perspective, human actors are juxtaposed with material non-human actors in a relational network, which implies that one part cannot be considered independently from the other. I will return to this in chapter 3, where the theories framing the research are presented.

Methodologically, the thesis explores the research inquiry empirically through three practice-based design experiments, examining the users' spatial awareness and the interplay between learning space and pedagogical practices using specific approaches and tools from the fields of co-design and constructive design research (Koskinen et al., 2011). This will be elaborated in chapters 4 and 5.

Ethical concerns

The research of this project was conducted with a participatory approach that made use of qualitative methods. This implies that various participants, such as teachers and students, were involved in the research process in close collaboration with the researcher. The nature of this type of participatory and qualitative research requires ethical considerations concerning e.g. anonymity, confidentiality and the role of the researcher, which I will elaborate in the following.

According to Brinkmann (2015), qualitative research (and research in general) is a value-laden activity that raises both ethical questions and potentials. Qualitative research often concerns private, subjective and intimate aspects of people's lives, which raises ethical privacy concerns as well as potentials for bringing awareness to marginalised topics and people.

Brinkmann draws attention to four ethical factors, which the qualitative researcher has to pay attention to:

A. informed consent from the research participants
B. confidence and anonymisation of the involved participants
C. the consequences that may arise for the participants from participation in the research project and finally
D. the role of the researcher in between involvement and independence.

In the following, I will explain how the first three factors have been treated in this project. The fourth factor has already been discussed in an earlier section of this chapter, where the many roles of the practice-based design researcher were addressed.

Informed consent from the research participants

The design experiments presented in this thesis took place in two Danish schools. The first experiment was part of a commercial redesign project, whereas the next two were mainly independent (experiment #2 and partly experiment #3). All experiments were approved by the school management and the participants were informed about the research project by their superiors. In addition, the parents of the children involved in the project were also informed about the project by the school management and in school B, the parents were asked to sign a consent form concerning the use of footage. A few were reluctant to sign because of the involvement of a commercial company in the project, and therefore some faces have been blurred in the photos. In school A, the photo documentation has been edited to prevent facial recognition, thereby bypassing the need for a written consent.

Confidence and anonymisation of the involved participants and the consequences that may arise for the participants from participation

To avoid any negative consequences for the participants following their participation in the project, I have chosen to keep the schools and participants anonymous. To keep the integrity of the employees and students, who participated in the experiments intact, the schools are only referred to, respectively, as school A and school B and the participants are never referred to by name, only by their profession and, when necessary, signature letter.

STRUCTURE OF THE THESIS

As described in this first chapter, the research project takes its point of departure in the challenges faced by creators of new learning spaces to design an environment where space matches practice. During the project, I have conducted three design

experiments concurrently with my literature studies. Thus, the structure of the thesis does not reflect the chronology of the research process.

The thesis is divided into three overall sections, flanked by an introduction and a conclusion. The first part of the thesis is devoted to the positioning of the research project in the field of learning space design and to the development of a theoretical framework and analytical model for the practice-based design experiments. The second part of the thesis introduces the research design, including the methodology and methods. The third part presents and discusses the design experiments in relation to the theoretical framework and existing research. In total, the thesis consists of seven chapters, which are briefly introduced in the following (besides the introduction) as a guide to the reader.

SECTION 1: Theoretical positioning

Chapter 2 introduces and maps current research into the design of learning spaces in order to position the inquiry. The chapter provides an overview of six overall research areas found in current literature that in various ways examine the connection between the design of learning spaces and teaching and learning. Chapter 3 provides a general introduction to the space-practice relationship in a relationalist perspective and establishes a theoretical foundation based on ANT and current research on the design and use of learning spaces. The chapter elaborates on relevant themes from existing research such as environmental awareness and competence and participatory design of learning environments and proposes a theoretical framework to back up and explore the empirical part of the project. Finally, it presents an analytical learning environment model to be used in the analysis of the design experiments.

SECTION 2: Research design

Chapter 4 introduces the research methodology and methods applied in this project. The chapter explains the notion of practice-based design research and describes how the project has been conducted as research through design based on a constructive design research methodology. Subsequently, it outlines and discusses the research project within a programmatic design research approach. Finally, the participatory and

qualitative methods and tools used to conduct the design experiments are described.

SECTION 3: Design experiments and discussion

Chapter 5 introduces and discusses the three design experiments. Each experiment is described and subsequently analysed in relation to current theory and the analytical model developed in chapter 3. Chapter 6 continues and closes the discussions from chapter 5 by elaborating on the findings in relation to the theoretical framework and existing research. Furthermore it evaluates the methodology and methods of the project.

Last, the concluding chapter 7 sums up the research project, outlines the limitations of the project and points to future research perspectives.

DEFINITION OF SPACE AND PRACTICE

In this section, the two terms that are most relevant to this thesis are explained: learning space and pedagogical practice.

Learning space / space

Learning space is one of two main concepts discussed in this thesis. During my literature research, I have come across a variety of understandings of the concepts of space and learning space. Some of these refer to space as both a social and a material construction, e.g. Cleveland (2011), Soja (1989) and Lefebvre (1991), whereas others define space materially as 'a geographic location and material form' (Nordquist & Watter, 2017, p. 327).

In this thesis, when talking about learning space or just space, I refer to the spatial design, meaning the physical layout of the educational environment and in particular the arrangement of furniture and artefacts. The reason is that these elements are most likely to enter into a dynamic relationship with the users and practice. Although I acknowledge the importance of the built environment such as ventilation, acoustics and lights (fixed), I have chosen not to address this matter in this thesis, since the 'success' of these elements depends strongly on professional and technical skills and

knowledge and that, once built, they are generally fixed and non-changeable. This is also a way to limit the scope of the research project. However, I would like to emphasise that these elements also ought to be addressed in a participatory design process, in particular light, which has the potential to be included as a tool in pedagogical practice (van Mil, Jeong, Larsen, Iversen, & Jörgensson, 2018).

In current research, learning spaces are also referred to as learning environments (e.g. Imms et al., 2016). The two terms are used synonymously across the disciplines by researchers within all three fields. An example is Blackmore, Bateman, Loughlin, O'Mara, & Aranda who change between learning spaces and learning environment in their literature review titled 'Research into the connection between built learning spaces and student outcomes' (2011). However, the term 'learning environment' mostly refers to a combination of several factors, such as pedagogical practices, school organisation and spatial design which, in aggregate, create the particular learning environment in a school. For instance, an innovative learning environment (abbreviated ILE) is defined as 'the product of innovative design of space and innovative teaching and learning practices' (Mahat et al., 2018, p. 8). The term 'learning environment' is used in a similar way in this thesis. When referring to the physical learning environment alone, this will be explicitly stated with the word 'physical'.

Pedagogical practice

The other main concept in this thesis is 'pedagogical practice', which I define as 'practices, strategies and styles of instruction engaged in by teachers and students'. In this, I draw on Cleveland (2011). The term 'pedagogical practice' encompasses the strategies used by teachers to teach the students as well as the learning activities that support the unit of content. The pedagogical practices can e.g. be teacher-centred, learner-centred, personalised learning, project-based, or support multiple student learning styles etc.

This thesis does not examine or assess a particular kind of pedagogical practice (or space) but is focused on the relationship between any given practice and design. Pedagogical practice is mostly addressed through the term 'practice' in order to make the thesis reader-friendly.

2 // MAPPING THE TERRAIN

Chapter 2 aims to draw up a landscape of the relevant literature informing the research of this thesis in order to position the research questions in the field of inquiry. The project is positioned within a cross-disciplinary scientific research field exploring the design of learning spaces in educational institutions. The chapter starts out with an introduction to the field of learning space research, followed by an outline of six overall research themes identified in current research that address the connection between the design of physical learning environments and teaching and learning. Finally, the chapter highlights current research gaps and explains how this thesis attempts to contribute to the research field of learning space design.

INTRODUCING LEARNING SPACES
—A CROSS-DISCIPLINARY FIELD

The field of design is the basis of this thesis, but it also draws on research in education and architecture as learning space research takes place in a cross-disciplinary field. The term 'learning spaces' is explained by Anne Boddington and Jos Boys (2011), both researchers from the fields of design and architecture, to be a collective title that describes an emerging and complex field situated at the confluence of a number of disciplines, including education studies, museum studies, research in architecture and design, estates planning, human-computer interaction, psychology as well as policy and management. Since my research focuses specifically on the influence of participatory design processes on the relationship between the physical design of learning spaces and pedagogical practices in primary and secondary schools, the literature review will mainly be oriented towards studies within the research fields of design, architecture and education that are concerned with the connection between the design of physical learning environments and teaching and learning in various ways.

In general, many current researchers concerned with the design of learning spaces agree that the interplay between the physical space and pedagogical practice is to be understood as interdependent. Inge Mette Kirkeby (2006) calls the interplay an 'interaction in which the "effect" of a given design on activities and behaviour at school is assumed to be user-dependent' (p. 6), and Boys (2011a) emphasises that space and its occupation are 'inseparable and interlocked, dynamically informing and influencing each other' (pp. 50-51). Dianne Mulcahy, Ben Cleveland & Helen Aberton (2015), researchers within both education and architecture at the University of Melbourne, build on Boys when they advocate for a relationalist perspective in learning space research, where space and practice are considered to be generated together. The assumption that the relationship between space and practice is an interdependent interplay is also a basic premise of this research project, which I will return to in the subsequent chapters.

MAPPING THE FIELD OF RESEARCH IN LEARNING SPACES

Research in learning spaces within design, architecture and education are often overlapping as they focus on both space and practice. According to R. A. Ellis and Peter Goodyear (2016), research in learning spaces is a relatively new field of study, seeking to inform the design, evaluation and management of learning spaces (p. 1). Based on an extensive desktop review, researchers Blackmore, Bateman, Loughlin, O'Mara and Aranda (2011) from the Centre for Research in Educational Futures and Innovation at Deakin University, point out that current research literature within learning spaces is informed by contemporary architectural and educational research and primarily focus on what is best design and best practice. They found that most research on learning spaces focuses on the design phase and that there is relatively little empirical research considering what happens once you are in the space. Kenn Fisher (2016) from Melbourne School of Design especially calls for more evidence concerning the impact of new generation learning environments in terms of what works and why. This is needed to underpin decisions regarding the design of new learning spaces and to convince teachers to change their pedagogical practices to match these new environments. This type of research is currently being attended to by researchers in Australasia, mainly through the research projects Innovative Learning Environments and Teacher Change (2016-2019) and Plans to Pedagogy (2018-2020). I will return to this later in this chapter. Boddington and Boys (2011) also claim that the field of learning spaces is under-researched. This is backed up by Mulcahy et al. (2015) as well as Nordquist and Watter (2017) from Karolinska Institutet (SE), whose focus is learning environments in medical education.

The aim of my project is to contribute to current research by exploring the interplay between learning space and pedagogical practice from a design perspective. The project is conducted with a specific focus on participatory design processes of learning spaces and collaborative activation of physical spaces in order to align the spatial design and pedagogical practice. During my literature studies, I found very little research coming from the field of design and even less with a practice-based research approach. I also did not find much research concerned with the relationship

between stakeholder participation (in particular teachers) in the design process and the actual, subsequent use of the space; nor did I find much research exploring actual tools and means to actively work with the interplay between space and practice in new or existing learning spaces. I will return to this discussion in the concluding section of this chapter.

In the mapping of existing literature investigating the interplay between space and practice the thesis builds on three meta-studies from 2005, 2011 and 2018 completed in England and Australia, respectively. It also draws on research projects and research publications from mainly Europe and Australia that have mapped and explored the interplay between the design and the use of learning spaces from various perspectives.

Most research regarding learning spaces comes from the field of education, which explains the domination of researchers from this field in the present literature review. However, despite coming from the same field, their interests and focus areas vary considerably. Whereas some research specifically focuses on the impact of learning spaces on student learning outcomes (e.g. Blackmore et al., 2011; Byers et al., 2014; Byers, Mahat, Liu, Knock, & Imms, 2018c; Higgins et al., 2005), other research mainly investigates the role of user participation in the design process as a tool to improve the final design (e.g. Könings, Bovill, & Woolner, 2017; Könings & McKenney, 2017) or how teachers use and transition into innovative learning environments (e.g. Imms, Mahat, Byers, & Murphy, 2017b). Still, these research areas interrelate and several researchers and research projects investigate more than one of these topics simultaneously and collaborate cross-disciplinarily within the fields of education, architecture and design. An example is the Innovative Learning Environments and Teacher Change project (ILETC) based in Melbourne that focus on how teachers are transitioning into innovative learning environments with the overall aim to improve learning outcomes for students.

As the design of learning spaces and its relation to practice naturally links to architecture, design and education, many researchers also work with cross-disciplinary topics. An example is Pamela Woolner from the School of Education at Newcastle University, who examines current issues in the design of learning environments from an educational perspective and builds on architectural work. In her research, Woolner

covers the physical design of learning spaces and how this affects different aspects of school life, including teaching and learning (Woolner, 2010; Woolner, Hall, Higgins, McCaughey, & Wall, 2007; Woolner, Thomas, & Tiplady, 2018). She also investigates the potential benefits of participatory design of new learning environments (Könings et al., 2017; Woolner, 2010; Woolner, McCarter, Wall, & Higgins, 2012).

Research from the field of design and architecture concerned with the interplay between space and practice is more limited. Within these studies, the main focus is on the interplay between pedagogy and architecture in primary and secondary schools (e.g. Kirkeby, 2006), the impact of environmental qualities (basic variables and built qualities like temperature, air quality, acoustics etc.) of the classroom design on student learning (e.g. Barrett, Davies, Zhang, & Barrett, 2015a, 2017), new types of learning spaces (e.g. Cleveland, 2016a; Fisher & Dovey, 2016) and the connection between the design and use of space in higher education (e.g. Boys, 2011a; Jamieson et al., 2000; Temple & Fillippakou, 2007). Much of this research proposes new ways to understand the dynamic relationship between space and practice as proposed by Cleveland and Fisher (2014), Dovey and Fisher (2014), Kirkeby (2006), Boys (2011a) and Mulcahy et al. (2015).

In addition to these focus areas, researchers within education, architecture and design are also interested in the technological side of new learning space designs (e.g. Brooks, 2011; Dori & Belcher, 2005; Higgins et al., 2005). While I recognise information and communictions technology (ICT) to be an important aspect of learning space design, this is beyond the scope of my research project and will not be examined further.

In the following, current research on the interplay between learning spaces and pedagogical practices from the fields of education, design and architecture is presented in more detail. Based on the themes identified above, the chapter is divided into separate sections. The titles of these sections are all deduced from the literature:

1. The connections between learning spaces and student learning outcomes;
2. New generations of learning spaces;
3. The physical design of learning spaces;
4. Participatory designing of learning spaces;

5. Evaluation of learning spaces and;
6. Learning spaces in post-compulsory education.

THE CONNECTIONS BETWEEN LEARNING SPACES AND STUDENT LEARNING OUTCOMES

The first research section is inspired by three extensive meta-studies informing the research concerning the impact of learning spaces on learning outcomes. The meta-studies document the multidisciplinary field of research in learning spaces with a particular focus on the relationship between the physical learning environment and student learning outcomes, which appears to be the most researched issue within the field of learning spaces. The research has been conducted over the course of 13 years in England (Higgins et al., 2005; Woolner et al., 2007) and Australia (Blackmore et al., 2011; Byers et al., 2018c).

The first extensive literature review about the impact of school environments was conducted by researchers from the research centre for Learning and Teaching at Newcastle University on behalf of the Design Council and CfBT (Education Development Trust), two British charitable bodies involved in school development (Higgins et al., 2005; Woolner et al., 2007). In this review, Higgins, Hall, Wall, Woolner and McCaughey (2005; 2007) look at the effects of changes in the learning environment on teachers and learners from a broad perspective that includes the physical learning space as well as other aspects like communication and services. The review is based on recent research (until 2005), mainly from the USA and UK and with a clearly reported empirical base (Woolner et al., 2007). The purpose is to show where there is empirical support for change and where there is conflict, inconsistency or complexity. An overall conclusion of the review is that there is a relative paucity of research on effective learning environments.

In order to map the field, Higgins et al. (2005) divide the body of literature into four areas that all affect learning and might be the focus of a design-led approach to change: systems and processes, products and services, environment and communication. The review shows that most research has been carried out in regard to the environment

(either the built environment understood as basic physical variables like air quality, temperature, noise, light and colour or the physical elements and layout of the classroom), less concerning systems and processes (the design process and roles and functions of the staff) and communication (within and beyond the school), whereas the least research has been on examining products and services (catering and community involvement).

Higgins et al. show that especially the impact of the built environment has been extensively researched with strong evidence in favour of the effect of the basic physical variables on learning (Fisher, 2001; Schneider, 2002). Research concerning the effects of other environmental features like lighting and colour is more conflicting (e.g. Knez, 1995; Veitch, 1997) and it is difficult to draw definite, general conclusions.

The layout of the classroom, in particular the arrangement of the students' desks and chairs (Wheldall & Lam, 1987), is one of the more well researched and debated issues (Higgins et al., 2005). Recommendations are varied as researchers examine rows and tables (Wheldall & Lam, 1987) or the 'horseshoe' formation (Martin, 2002). Other spatial elements like the possibility of display and storage (Killeen, Evans, & Danko, 2003; Loughlin & Suina, 1982) are also highlighted as beneficial for learning.

Higgins et al. especially highlight the importance of user involvement and point out that the success or failure of school design is determined by the extent to which, and the ways in which, the users of the schools are engaged in the design process. Genuine involvement of both students and teachers in the design process is recommended (Clark, 2002; Dudek, 2000) and users are generally empowered by understanding and being able to alter their environments (David, 1975; Martin, 2002). According to Higgins et al., this produces greater satisfaction and is expected to improve the design. The spatial setting and the style of teaching is dynamically linked (Martin, 2002), but space does not by itself change how teachers teach (Rivlin & Rothenberg, 1976). On the contrary, human beings tend to resort to simply coping with the given environment rather than actively managing it, which might be related to users not being involved in the design process (Higgins et al., 2005).

Higgins et al. (2005) regard schools as systems in which the environment is one of many interacting factors and that any outcome from a change in setting is most

likely produced through a chain of events. They conclude that no design solution will last forever in a changing world, which is why 'the process of user involvement must be continually refreshed and iterated to support ongoing change' (p. 03). Their point is that the most successful learning space designs are likely those that are seen as interim solutions with an element of flexibility and adaptability.

Drawing on the review by Higgins et al., educational researchers from Deakin University in Australia have updated and extended the review of literature concerning learning spaces and student outcomes until 2011 in a report for the Department of Education and Early Childhood Development in the State of Victoria, Australia. Blackmore, Bateman, Loughlin, O'Mara and Aranda (2011) have looked at the current state of research into the connections between learning spaces in schools and student learning outcomes, which broadly include the social, affective, physical and cognitive changes in students. Their main target is international and national literature on both primary and secondary schools as well as higher education from 2000-2010. The purpose of the review is not only to find evidence to support connections between learning spaces and student outcomes but also to show gaps in research and propose future research areas.

The review by Blackmore et al. (2011) presents a conceptual framework of four temporal phases to map current research addressing connections between practitioners, learners and spaces, which covers a design phase (design principles, environmental conditions, design processes), a transition and implementation phase (practical aspects of transitioning into new buildings, organising services, resources and space, the nature of systems supports, developing new organisational arrangements, and establishing rules and protocols of use), a consolidation phase (the relationship between space, use and users) and a sustainability/re-evaluation phase (long-term effects of new physical spaces and built environments). The division of research areas according to temporalities is different from the division by Higgins et al. (2005) but the findings are quite similar. Most research is found in the design phase (e.g. Fisher, 2005; Higgins et al., 2005; Oblinger & Lippincott, 2006; Temple & Fillippakou, 2007), followed by the consolidation phase (e.g. Blatchford, Baines, Rubie-Davies, Bassett, & Chowne, 2006; Dudek, 2000). Little research is found in the transition and implementation phase

(e.g. Gislason, 2009; Thomson, Jones, & Hall, 2009) as well as in the sustainability/re-evaluation phase (mainly reports from the UK's Building Schools for the Future (BSF) program, e.g. PricewaterhouseCoopers, 2003; PricewaterhouseCoopers, 2007).

In general, the review identifies very little empirical evidence that associates any of the four phases with student learning outcomes and literature mostly focus on the qualities of conditions, perceptions or tangibles (e.g. quality of air, light, temperature) rather than educational practices or intangibles (e.g. school culture) in regard to how space is used and to what effect (Blackmore et al., 2011).

Agreeing with Higgins et al. (2005), Blackmore et al. (2011) highlight the interest in environmental impacts on student learning as a key theme across the design phase literature. Much literature attempts to link desirable student outcomes with particular elements of design and set up design principles as exemplars of the redesign process (e.g. Committee, 2006; Jamieson et al., 2000; Oblinger, 2006). The dominant theme is that learning spaces need to be pedagogically and physically flexible in order to facilitate multimodal pedagogies and accommodate individual learning (Blackmore et al., 2011).

Another key theme in the design phase is the significance of the design process for the subsequent use of the space (Fisher, 2005; Higgins et al., 2005; Jamieson et al., 2000; Radcliffe, Wilson, Powell, & Tibbetts, 2008). Research suggests that a participatory design process will improve teacher practices and students' learning experiences (Fisher, 2002; Higgins et al., 2005; Temple & Fillippakou, 2007) and the input from teachers is said to be critical (Higgins et al., 2005; Temple & Fillippakou, 2007).

The review identifies little research on what happens in practice as spaces are used by teachers and students. The main focus in this area is on the relationship between spatial design and collaborative teaching and learning (Blatchford et al., 2006; Wolff, 2002), the connection between poor spatial conditions and negative learning (Fisher, 2002; PricewaterhouseCoopers, 2003) and the environmental qualities of the space (Fund, 2009; Schneider, 2002). In particular Dudek's (2000) work on the historical development of educational architecture and design is elevated as evidence of the links between space, pedagogy and outcome (Blackmore et al., 2011).

The review points out that claims in the literature about the possible effects of

various aspects of learning spaces on student learning are often not substantiated empirically and much literature, especially in the design phase, is aspirational in assuming that changes in learning space design will result in changes in teaching and learning.

Recently, a third review within the same research area has been published by researchers from the University of Melbourne (Byers et al., 2018c). The review is one of several publications from the ILETC project that overall tries to build an understanding of how physical classroom space impacts on learning and how best to support teachers in making the most of the spaces in their schools (Imms et al., 2017a). The project is anchored at Melbourne Graduate School of Education (2016 till 2019) and involves researchers with backgrounds in education, design and architecture.

Drawing on studies from the integrated fields of education and design, the review specifically attempts to identify three factors in relation to the impact of learning environments on student learning outcomes (Byers et al., 2018c, p. 38):

1. What empirical evidence exists that considers the impact of learning environment types, innovative learning environments (abbreviated ILEs) in particular, on student learning outcome measures;

2. The measurement tools used to gather this evidence and;

3. The types of evidence these tools elicit.

From 5,521 articles retrieved, only 21 papers published since 1960 were found to have an adequate quality, sampling and statistical process to isolate and evaluate the impact of different learning environment types and therefore included in the review.

A small number of studies presented evidence of a positive connection between the learning environment, in particular ILEs, and student achievement (Byers et al., 2014; Fößl, Ebner, Schön, & Holzinger, 2016), whereas other studies comparing open learning environments and traditional classrooms suggested that open-plan settings had a negative impact on student academic achievements (Forman & McKinney, 1978; Reiss & Dyhdalo, 1975; Solomon & Kendall, 1976). Byers et al. explain this dilemma as a historical ambiguity (1970s versus the 2000s) and blames methodological weaknesses in the research methods used in the 1970s account for the contrasting results (Byers et al., 2018c).

Several studies compared student academic outcomes in a blended (digital/physical) learning environment and a traditional classroom setting (Chandra & Lloyd, 2008; Cicek & Taspinar, 2016; Kazu & Demirkol, 2014), revealing that students in blended learning environments achieved relatively higher academic success (Byers et al., 2018c).

Other studies focused on the correlation between various designs or physical factors (e.g. group meeting places, positive outdoor spaces, clearly defined pathways, daylight and views) and student academic outcomes (Tanner, 2000, 2008), as well as the environmental or physical conditions (e.g. air quality, temperature, lighting) in existing classroom spaces that were optimal for student learning (Barrett et al., 2017; Barrett, Zhang, Davies, & Barrett, 2015b).

In conclusion, the review points out an emerging trend suggesting that different ILEs have a positive impact on student learning outcomes, but very few quality evaluations actually exist to validate this impact (Byers et al., 2018c). In this regard, the review supports assertions made in the earlier reviews by Higgins et al. (2005) and Blackmore et al. (2011) that current literature lacks substantive, empirical evidence about the impact of different learning space layouts on student learning outcomes (Byers et al., 2018c).

NEW GENERATIONS OF LEARNING SPACES

In their literature review, Blackmore et al. (2011) point to a lack of research concerning the transition into new learning spaces and the types of practices that emerge in these altered settings. However, in recent years a new cross-disciplinary study area has emerged, interested in the impact of new generations of learning spaces and the appropriation and transition into these spaces (e.g. Bradbeer et al., 2017; Imms & Byers, 2017; Imms et al., 2017b; Sigurðardóttir & Hjartarson, 2016). The new generations of learning spaces especially refer to innovative types of informal, non-hierarchical and flexible spaces like open-plan learning spaces (Alterator, 2015; Alterator & Deed, 2013), innovative learning spaces (Bradbeer et al., 2017; Byers, Imms, & Hartnell-Young, 2018a; Imms et al., 2017b) and new generation learning spaces (Byers & Imms, 2018).

Overall, the research in this area points to a positive connection between new types of learning spaces and a change in pedagogy towards a more student-centred teaching approach, more active pedagogies with greater levels of activity differentiation and increased student deep learning, student engagement and student learning outcomes (e.g. Bradbeer et al., 2017; Byers & Imms, 2018; Byers et al., 2018b; Cleveland, 2016a).

Over the last years, several research projects concerned with the design and use of innovative types of learning environment have been conducted in Australia under the multi-disciplinary forum LEaRN (Learning Environments Applied Research Network), based at the University of Melbourne. These projects include the ILETC-project (2016-2019) mentioned in the previous section, and a very recent project 'Plans to Pedagogy' (abbreviated P2P, 2018-2020), both anchored at Melbourne Graduate School of Education. Other large research projects linked to LEaRN have investigated how to evaluate new learning environments (Evaluating 21st Century Learning Environments 2013-2016, abbreviated E21L) and the influence of innovative and sustainable school building designs on middle-years education in Victoria (Smart Green Schools, 2008-2011). Several of these projects are ongoing at the time of this thesis (ILETC and P2P) which is why final conclusions and results are not yet available.

Key findings from the LEaRN projects indicate that the particular configurations of learning spaces do have an impact on teaching and learning (e.g. Byers & Imms, 2018; Byers et al., 2014; Cleveland, 2016a) and that carefully considered and innovatively designed learning spaces have the potential to encourage higher levels of student engagement and catalyse the adoption of more constructivist pedagogies (Cleveland, 2016a; Fisher, 2016). They even indicate that traditional classrooms are associated with markedly lower characteristics of positive teacher mind frames and student deep learning. Bradbeer et al. (2017) describe teacher mind frames as the mediating variable that directs how teachers think and act when engaged in all aspects of teaching (after Hattie, 2012), whereas student deep learning is explained as learning for understanding through authentic tasks that involves problem solving and critical thinking and discussion. This is in contrast to surface learning, which basically is 'learning for a test' (Bradbeer et al., 2017, p. 26). Yet classrooms still make up for approx. 75% of learning spaces in Australasian schools (Imms et al., 2017a).

Other studies in new types of learning spaces focus on the connection between space and teacher practice in open plan learning environments, indicating a connection between the openness of the learning space and enhanced teacher collaboration (Alterator & Deed, 2013; Broens; Deed & Lesko, 2015; Deed, Lesko, & Lovejoy, 2014; Gislason, 2009; Sigurðardóttir & Hjartarson, 2011, 2016). The collaboration between teachers and other professionals in open plan learning environments is yet another research subject (e.g. Frelin & Grannäs, 2017). However, according to Neil Gislason (2018), the success of these new types of learning spaces depends on the interrelation of four elements—the physical design, organisation, educational culture and student dynamics. These four elements combine to produce a school's total learning environment and are thus proposed by Gislason (2018) as a framework for communication between educators and architects during the planning process of new innovative learning environments. This corresponds with findings by Byers and Imms (2018), who point out that new generations of learning environments by themselves are not the agents of change; the use depends on the environmental competence of the teachers.

THE PHYSICAL DESIGN OF LEARNING SPACES

Most contributions from an architectural and design perspective deal with the link between the physical design of learning spaces (e.g. the environmental qualities or the physical setting) and its relationship to or impact on teaching and learning. In general, research from this point of view was found to be limited and mainly performed by architects and other construction professionals. Part of this research has already been presented earlier in this chapter, i.e. research by Barrett, Davies, Fay and Barrett (2015a, 2017), who, through a study of 153 classrooms in 27 UK primary schools, have identified seven key design parameters (Light, Temperature, Air Quality, Ownership, Flexibility, Complexity and Colour) that affect the academic progress of students or research in innovative learning environments by the University of Melbourne (Cleveland, 2016a). Other studies focus more on specific details of the design and its influence on practice, i.e. how the distribution of artificial light impacts on student learning (van Mil et al.,

2018) or how flexibility in learning spaces affect learning (Woodman, 2016).

The nature of the interplay between practices and architecture and the different factors that influence this interplay is explored by e.g. Kirkeby (2006), Ricken (2010) and Boys (2011a). Inge Mette Kirkeby (2006) has identified different aspects of the interplay between architecture and pedagogy and compiled these in an analytical model consisting of five types of spatial concepts and related design principles for use in future school building processes. Winie Ricken's (2010) main focus is the impact of the interplay on the students' choice of action and how this in turn relates to the development of children's health. A main finding in her PhD project is that an optimised interplay between the architectonical and pedagogical parameters in learning environments requires a consensus between the organisation of the school and the overall educational goals in relation to the pedagogical practice and the physical spaces. Boys (2011a) and Gislason (2018) likewise suggest that the physical environment is one of several elements feeding into the learning environment and that these elements should all be considered when examining the relationship between space and practice.

Through an analysis of 59 notable and award-winning school designs, Kenn Fisher and Kim Dovey, both from Melbourne School of Design, define a framework to analyse the range of spatial experimentation taking place in response to changing pedagogies (Fisher & Dovey, 2016). The framework consists of five learning cluster typologies, where each typology contains a varied layout of space types, ranging from the traditional closed classrooms connecting to a corridor or access space to the totally open learning environment. The studies by Fisher and Dovey (2016) as well as the ILETC-project (e.g. Imms et al., 2017a) show that the traditional classroom still dominates school architecture, which explains a continuing research focus on the design of the classroom and more formal types of learning environments (dominated by a teacher-centred pedagogy) (e.g. Brooks, 2011, 2012; Martin, 2002; Martin, 2006; Stadler-Altmann, 2015; Temple & Fillippakou, 2007; Tondeur, Herman, De Buck, & Triquet, 2017).

Another minor study area is the impact of the design of classroom environments on the practice of teachers. In a study of teachers' classroom behaviour, Sandra Horne

Martin (2002) concludes that there is a need for training and retraining environmental awareness and competence in teachers in order to help them understand the effects that the classroom has on them and empower them to redesign their physical environment according to educational purposes. The same request for teacher training in order to improve the teachers' understanding and use of the environment as a teaching tool is put forward by Jeffery Lackney (2008), who, at the same time, points out that the problem of environmental competence concerns the whole organisation of the school and not just the individual teachers. Other researchers likewise point to the need for ongoing support in adapting to new learning environments, e.g. Cleveland (2016a) and Sigurðardóttir and Hjartarson (2016). However, very little research examines how this support could be conducted. Recently, the ILETC-project has released a survey to gather data on the teachers' perspectives on their transition from traditional classroom spaces into more innovative learning environments as part of their research aiming to develop and try out strategies to assist teachers in adapting their teaching to different types of innovative learning environments (http://www.iletc.com.au/survey2/, May 15, 2019).

PARTICIPATORY DESIGN OF LEARNING SPACES

Recently, a growing interest in participatory design of learning spaces has emerged of which a number of studies and researchers are represented in a thematic issue of the European Journal of Education from 2017. Focus in this research area, referred to by Könings et al. (2017) as 'participatory building design', lies on the significance of stakeholder participation in the design and building process and the process of developing building programs for physical learning spaces as explained by Nordquist and Watter (2017). Most researchers within this field come from an educational background, but the research is cross-disciplinary as it attempts to propose different ways to include the users in the design and building process.

   A large part of this research seems to have emanated from the UK as part of or relating to the major school investment program in secondary schools, Building Schools for the Future (BSF) in the 2000s. That also applies to research by i.e. Pamela

Woolner (2009, 2010; Woolner et al., 2012), Heppell et al. (2004) and Rosie Parnell, Vicky Cave and Judith Torrington (2008). In several books and articles, Woolner examines the potential benefits of participatory design of learning spaces on the relationship between design and use and highlights the importance of a collaborative approach and genuine dialogue with a wide range of stakeholders in the design processes. Similar assumptions are made by Parnell, Cave and Torrington (2008), researchers in architecture, who, based on twenty interviews with architects and facilitators of school design processes, suggest that there is a need to acknowledge the opportunities which lie within the collaborative design process and not just be fixed on the product, the finished school. In a research report from a research project on future schools by CABE (Chartered Association of Building Engineers) and RIBA (Royal Institute of British Architects), Heppell et al. (2004) emphasise, amongst other things, the importance of involving learners in the research design process as this is believed to enrich their learning and through this progress school standards.

Research highlighting the importance of participatory design processes of learning environments is also published from other European countries. Findings by Sigurðardóttir and Hjartarson (2016), who examine school buildings in Iceland, likewise suggest that collaborative design processes can work as a tool to implement an educational vision in a new school building.

In a thematic issue of the European Journal of Education from 2017, 'Participatory Design of (Built) Learning Environments', researchers from a joint Dutch and British research and networking project examine the participatory design of learning environments from various perspectives that all deal with multidisciplinary collaboration related to the development of physical learning spaces (Könings & McKenney, 2017). The researchers featured in this issue mainly write from an educational perspective (e.g. Karen Könings, Jeroen J. G. Van Merriënboer and Susan McKenney); however, architectural academics (e.g. Alexander Koutamanis) and practitioners (e.g. Architect Dominic Cullinan) also contribute.

As the title indicates, the thematic issue covers more aspects of the learning environment than just the physical design. The issue is the first collection of articles on the topic that I have come across, which suggests a growing interest. The editorial

of the magazine claims that participatory design is considered a valuable approach for instructional design, which is expanded to include the architecture of the physical spaces in which education takes place (Könings & McKenney, 2017), thereby indicating that participatory design of physical learning environments is a fairly new research field. This also corresponds with an observation by Nordquist and Watter (2017) about the scholarship in the special issue being primarily conceptual.

All of the articles explore the multidisciplinary collaboration related to the development of physical learning environments, as explained by Könings and McKenney (2017). However, some emphasise the impact of physical space on learning (Hall, 2017; Nordquist & Watter, 2017; Tondeur et al., 2017; van Merriënboer, McKenney, Cullinan, & Heuer, 2017), whereas others focus on participatory design processes (Janssen, Könings, & van Merriënboer, 2017; Koutamanis et al., 2017; Könings et al., 2017; Könings & McKenney, 2017). All researchers, however, agree on the importance of user-involvement in the process of developing new learning spaces. An overall topic is therefore why and how to involve the end users (teachers and students) in the design process (Nordquist & Watter, 2017).

To facilitate the involvement of stakeholders in the design process of both instructional and physical learning environments, in particular in the early pre-design phases, different participatory design models are proposed as tools, e.g. a theoretical four-component instructional design model (4C/ID) (van Merriënboer et al., 2017), the laddering tool and the building block tool (Janssen et al., 2017) or an interdisciplinary model of participatory building design in education (Könings & McKenney, 2017). The models have slightly different focus areas but all attempt to provide transparency and guidance in order to enable participation of stakeholders in educational building projects (Nordquist & Watter, 2017).

EVALUATION OF LEARNING SPACES

Following the increase in design of new types of learning environments, researchers have started to investigate methods for evaluation of these new environments. The research includes existing evaluation tools as well as the development of new

approaches to learning environment evaluations. Much of this research is presented in two books, published in Australia, where researchers propose different strategies for assessing how these new environments actually work (Alterator & Deed, 2018; Imms et al., 2016).

According to Cleveland (2016b), the field of post-occupancy evaluation (POE) has directed how evidence about the performance of educational facilities has been gathered for over 40 years. However, such work has generally overlooked the sustainability of the physical environment in supporting pedagogical practices. Cleveland (2016b) criticises best practices in physical learning environment evaluation, i.e. Sanoff's (2001) School Building Rating Scale tool or the Design Quality Indicators for Schools (DQIfS) tool (CABE, 2005), for omitting considerations of the social or human components of the learning environment and calls for new methods that make explicit the connection between pedagogy and space. Similarly, Graeme Oliver (2016) points out that current models of evaluation tend to be situated in separate domains of either architecture or education. He suggests a new model that enables both architectural and pedagogical perspectives as a tool to evaluate the effectiveness of innovative learning environments in supporting the achievement of innovative educational practices. Another evaluation method is presented by Terry Byers (2016), who proposes a quasi-experimental and single-subject research design approach to investigate the effectiveness of physical learning environments as an alternative to traditional methodologies used in post-occupancy evaluations of learning environments.

A review of post-occupancy evaluation tools is presented by Acton, Riddle, and Sellers (2018), who list the most common evaluation tools which are: surveys, interviews, focus groups and observations of teaching practice. Furthermore, they present other emergent methods for spatial evaluation such as the Most Significant Change (MSC) approach, which is a narrative-based dialogic process and the Day Experienced Method, which uses diary entries, photographs, videos and audio recordings by students to study their perspectives and experiences. They also highlight document analysis of policy or institutional documents as a tool to compare intentions with enacted practice. Other post-occupancy tools are proposed by e.g. Prain (2018), who suggests quantitative methods to evaluate students' post-occupancy perceptions

of personalised learning in an innovative learning environment and Jo Dane (2016), who has developed an evaluation tool, The Effective Teaching and Learning Spatial Framework as part of her PhD research. The latter addresses in particular new generation learning environments in higher education (university campuses).

LEARNING SPACES IN POST-COMPULSORY EDUCATION

The design and use of learning spaces in post-compulsory and higher educational institutions is yet another focus area that has seen a small but growing development lately (Boys, 2011a; Ellis & Goodyear, 2016; Jamieson et al., 2000; Temple & Fillippakou, 2007). As this thesis examines the relationship between space and practice in schools, the field of higher education is not within its research scope. However, I have found a great deal of overlapping themes during my literature research, which is why I have chosen to include a short overview of relevant key themes and findings in this chapter, mainly based on a recent literature review by Ellis and Goodyear (2016) and research by Boys (2011).

Similar to research on learning spaces at school levels, researchers within the field of learning spaces in post-compulsory education highlight a lack of research on the use of space (Boys, 2011a; Ellis & Goodyear, 2016; Temple, 2008). According to Ellis and Goodyear (2016), this topic is both under-researched and under-theorised and the body of literature is disperse and fragmented.

In their review, Ellis and Goodyear (2016) identify two main domains within the research literature of learning spaces in higher education, physical and virtual learning spaces, respectively. Relating to the scope of this research project, I will only look at research within the first domain, physical spaces. Ellis and Goodyear explain how research in physical learning spaces mainly tend to come from architecture (concerned with the built space), environmental psychology (concerned with space design issues) and the learning sciences (concerned with pedagogy and curriculum space design issues). Within these, there are especially three research foci: formal learning spaces (e.g. Brooks, 2011; Dillenbourg, 1999; Gibbons, 1994), informal learning

spaces (e.g. Boys, 2011a; Jackson & Shenton, 2010) and the meaning of learning spaces, in particular the students' experiences of specific learning spaces (Eisenbach, 2008; Melhuish, 2011). Especially the first category, research focusing on formal learning spaces, shares many common themes with research in schools, as much of this research deals with the configuration and affordances of physical learning spaces. Ellis and Goodyear define formal learning spaces as physical spaces 'in which the teachers and students are typically co-present and in which the activities are either teacher-centred or teacher-supervised' (2016, p. 16). Overall, research on formal learning spaces identifies a tension between form and function in contemporary learning spaces, which partly arises from a mismatch between traditional learning spaces such as the lecture theatre and changes in pedagogy towards an understanding of knowledge production as happening through collaboration and authentic engagement (Ellis & Goodyear, 2016). According to Ellis and Goodyear, current research points to a connection between the spatial design and particular activities and shows that different types of spaces encourage different types of student activities. This in turn leads to the suggestion that the desired outcome should inform the selection or reconfiguration of the learning space (Ellis & Goodyear, referring to Brooks, 2011, p. 18). At the same time, new configurations of learning spaces place new demands on the teachers, which has led to theoretical ideas about 'classroom orchestration' (e.g. Dillenbourg, 2013), aimed to create an understanding of the dynamics of classroom activities and provide tools and techniques to make the teacher's work more efficient and effective (Ellis & Goodyear, 2016).

Other studies in formal learning spaces look at the relationship between the built qualities of space and learning, i.e. visual and audio comfort (Bellia, Cesarano, & Spada, 2005) as well as colours and type of setting (Rivlin & Weinstein, 1984; Stone, 2001), which are similar to studies in schools.

A phenomenon that is highlighted as relevant for our understanding of learning space design and use in both schools (Gislason, 2018; Mulcahy et al., 2015; Ricken, 2010) and higher education (Ellis & Goodyear, 2016) is the relational nature of different aspects of the learning environment. According to Ellis and Goodyear (2016), 'the design, management and use of learning space should be a shared concern for all

members of a university: a collective responsibility, the discharge of which can benefit all participants' (p. 2). They underline this connection by pointing out that ways of conceptualising space which ensure a strong connection between decisions about the design and management of space and the core activities of learning and teaching are needed to manage space to promote learning.

Inspired by Henry Lefebvre (1991), Boys (2011a) likewise proposes that the relationship between space and the activities taking place in it should be examined through a three-part conceptual framework consisting of the designed learning environment, ordinary social and spatial practices of existing communities and the individual engagement with and adaptations of the social and spatial practices and spaces (pp. 7, 81, 174). According to her, this framework can illuminate the tensions and problematics between these three aspects and thus inform a new understanding of the relationship between space and occupation. Boys points out that the relationship between space and practice is complex and partial as space and occupation endlessly inform and influence each other and she concludes that altering spaces does not automatically change processes and practices. The same non-causality between space and practise is emphasised by Ellis and Goodyear (2016), who explain the nature of association between the structure of learning space and meaningful students learning as an indirect association rather than a direct and causative relationship. Drawing on Lansdale, Parkin, Austin, and Baguley (2011), they point out that the structure of space alone is insufficient to achieve changes in the interactions of participants in the space and the effects of space on outcome are therefore mediated by other factors. Similar indications are found in research in schools as presented earlier in this chapter.

THE GAP IN RESEARCH ON THE RELATIONSHIP BETWEEN LEARNING SPACE DESIGN AND PRACTICE

As presented in this chapter, a common assumption in current literature is that the physical learning environment plays a central role for pedagogical practices. The affordances of a space are believed to support or obstruct specific types of practice

(Woolner, 2010). However this relationship is not considered to be causal (Mulcahy et al., 2015), meaning that certain types of spaces do not automatically lead to a specific way of teaching or learning. Researchers like Boys (2011a) and Gislason (2018) suggest that the physical environment is part of an interdependent relationship consisting of social and architectural elements that in combination produce a school's total learning environment.

Still, as emphasised by several researchers (e.g. Blackmore et al., 2011; Boddington & Boys, 2011), research in this field is limited and often focuses on the physical design of learning spaces, rather than the actual use of these spaces. Historically, little research has explored the transition into new spaces and the continuous use by teachers and students. This is partly changing now, however, with research projects like the ILETC-project in Australia. Key findings from this project suggest a link between the spatial setting and changes to teaching and learning, although this depends to a large extent on the environmental competence of the teachers (Byers & Imms, 2018; Byers et al., 2014; Byers et al., 2018b).

The following sections attempt to highlight some of the gaps found in current research. As presented in this chapter, six overall themes have been identified in current literature, mostly emanating from the field of education. In general, the literature presented in relation to the six themes was found to be conceptual and theoretically founded, whereas little research actually intervened in or was based on practice (two exceptions are e.g. Imms & Byers (2017) and van Mil et al. (2018)). Nordquist and Watter (2017) explain that research in participatory building design has the ambition of creating practical models and tools to involve stakeholders in the development of physical learning spaces. However, this is still a comparatively undeveloped field. The same applies to the transitioning into and appropriation of new spaces. In their literature review, Blackmore et al. (2011) found little empirical research analysing how students and teachers negotiate and create new relationships, organisational structures and processes in the use of new learning spaces and no recognition of the importance of the need to prepare teachers through ongoing professional learning for use of new learning spaces. This is also emphasised in critical pedagogy and effective schools literature (Blackmore et al., 2011). In addition, more research is requested by

Woolner et al. (2007) concerning the effects of the design process on teachers' and learners' locus of control in regard to other aspects of school life and by Woolner et al. (2018) on how the social and physical aspects of school structures interact with each other and with the cultural assumptions and opportunities for individual agency.

Another gap in literature is actual strategies and tools for stakeholder participation, especially teachers, in the design process of new learning space as well as ways of transitioning into these new spaces. Both were found to be very limited and rarely tested in practice. Research on the actual use of new types of spaces, including strategies for assisting teachers in adapting their teaching to new spaces, was mainly found to be conducted as part of the ongoing ILETC project.

As concluded here, there is a gap in research when it comes to practice-based design research concerned with the designing and appropriation of learning spaces. This thesis attempts to add a brick to the bridge over this scientific gap and respond to some of the calls for research presented earlier by investigating the interplay between learning space design and pedagogical practice through a practice-based design research approach and with a specific focus on the users in the design process and in a following transition and appropriation process. It explores the relationship between stakeholder involvement in the design process and the following practice in the new space as well as tools for teacher training in environmental awareness and competence as a means to inform the relationship between space and practice. It thereby attempts to link education and design as well as concept and practice.

In the following chapter, the literature associated with the theoretical framework that has informed the analysis of the design experiments and discussions of the research findings is presented and discussed. This chapter will also serve as a basis for the theoretical positioning of the thesis.

UNLOCKING LEARNING SPAC

A guest lecture by Bodil Bøjer & Rune Fjord

3 // A RELATIONALIST THEORETICAL FRAMEWORK

In chapter 3, a relationalist perspective is introduced as a theoretical framework for the exploration of the space-practice relationship. The relationalist perspective is discussed based on current research in learning spaces and ANT. This is followed by a discussion of the significance of the physical space in relation to practice and the notion of environmental awareness and competence. Next up, research on participatory design processes of learning environments is presented and discussed. The concept of makers of spaces is introduced as a substitute for users of spaces, which assigns the user an active role in activating and reconfiguring learning space designs. Finally, based on the relationalist approach to learning spaces, I argue that the space-practice relationship depends on social, organisational and material factors as well as the teachers' environmental awareness and competence. I refine the theoretical framework by exploring different models and frameworks for exploration of learning environments, which I use to develop a new theoretical framework, 'a learning environment triangle', as a tool for analysis of the space-practice relationship.

AN INTERDEPENDENT RELATIONSHIP

This research project is grounded on the assumption that the relationship between the physical space and pedagogical practice is a constant, complex and interdependent interplay, where each part informs and influences the other. In this, I build on current researchers in learning spaces such as Kirkeby (2006), Boys (2011a), Woolner (2010), Mulcahy et al. (2015) and Gislason (2018), who all emphasise the relational character of the interplay between space and use.

The idea of space and practice as interdependent is a recurring theme in recent literature that succeeds a realist understanding of space and practice as binary oppositions. Much research in learning spaces suggests a strong relationship between the spatial environment in a school and the activities that take place there, where space and practice constantly interrelate and interact, e.g. Boys (2011a), Kirkeby (2006), Martin (2002) and Woolner et al. (2018). In this view, space and practice are understood to be generated together rather than just reflecting each other.

Research by Woolner (2010), Woolner et al. (2018) and Kirkeby (2006), amongst others, suggests that different spatial settings can either facilitate or impede pedagogical and social practices. As shown in the previous chapter, innovative types of learning environments have for example been found to support a more student-centred approach to learning and foster teacher and student collaboration in a study by Cleveland (2016a). In other studies, e.g. by Gislason (2007) andSigurðardóttir and Hjartarson (2011), schools with cellular classrooms and traditional furniture settings in a rectangular layout were claimed to constrain collaboration and promote a more teacher-centred pedagogy. This indicates that space does influence practice.

At the same time, research by Imms and Byers (2017) and Mulcahy et al. (2015) also suggest that space alone does not change practice and that there is no causal link between learning spaces and pedagogic change. As Woolner et al. (2018) point out, the evidence base relating to the impact of the physical setting on learning is complex and it is commonly agreed in research that the physical environment does not determine educational activities. According to Byers and Imms (2018), the way the physical learning environment is inhabited is at least as important as its design in terms of the impact of space on learning. Therefore, researchers, e.g. Woolner (2010), explore

the importance of involving the users in the design process and how this should lead to more appropriate, closed fitting designs. However, this might not even be enough to create a simultaneous change in space and practice, which is why researchers like Cleveland (2016a) and Martin (2002) suggest that teachers require ongoing support and training if they are to adopt new pedagogies and make the most of their physical learning environments.

The purpose of this chapter is to establish a scientific foundation and theoretical framework for the design experiments in my research project. Building on the insights presented above, the relationship between learning space design and pedagogical practice is explored with a particular focus on stakeholder and user participation in the design and activation of new learning spaces. In this, the research project mainly draws on research concerning the nature of the relationship between space and practice (e.g. Boys, 2011a; Kirkeby, 2006; Mulcahy et al., 2015), participatory design processes of learning spaces (e.g. Könings & McKenney, 2017; Woolner, 2010, 2015) and environmental awareness and competence (Lackney, 2008; Martin, 2002). On a meta-level, the project also draws on ANT (Latour, 2005) to explain the relational nature between learning space and pedagogical practice. Finally, in order to create a theoretical framework for the analysis of the design experiments, the chapter presents and compares learning environment theories and models developed by Boys (2011a), who builds on The Spatial Triad by Lefebvre (1991), Ricken (2010), Mulcahy et al. (2015) and Gislason (2018). Subsequently, these are merged and developed into a new learning environment model, which serves as a tool in the data collection and analysis of the experiments.

CONSIDERING LEARNING SPACES IN A RELATIONALIST PERSPECTIVE

In an article from 2015, Mulcahy et al. argue in favour of a change in the discourse on learning spaces from a realist to a relationalist understanding. According to them, the discourse on learning spaces has been dominated by a realist framing, which takes its point of departure from fixed entities such as the built environment, design features

and learning outcomes. In the realist perspective, space and occupation is considered in a binary framing, where 'space and its uses are taken to be different aspects that reflect each other' (p. 578). Space is presumed to be given in advance of practice and then appropriated. This implies a causal logic, where space and occupation are directly related in such a way that a change of space will change practice. In a relationalist perspective, the physical space and pedagogical change are understood to be generated together. Space and use are no longer regarded as binary oppositions that reflect each other, but as inseparable and interlocked parties in a relationship, where they dynamically inform and influence each other (Mulcahy et al., 2015, referring to Boys, 2011b). This means that space is not considered a given, but comes into existence with its users. The relationalist perspective, as proposed by Mulcahy et al., builds on social and cultural theorists such as Massey (2005), Soja (1989) and Thrift (2008), who acknowledge the spatial to be socially constituted and space and time conjoined. Hence, a learning space is explained by Mulcahy et al. as a product of interrelations and materially embedded practices rather than just a physical building.

The same considerations are stated by Boys (2011a) and Kirkeby (2006), who both argue that we need to rethink the relationship between space and practice. Like other researchers, e.g. Blackmore et al. (2011), Boys (2011a) claims that current learning space design (in post-compulsory education) is based on simplified notions of learning spaces, where a new space in itself is assumed to change teaching and learning. However, as Boys points out, there is no perfect fit between a learning activity and its spaces. Space is a 'relationship rather than a setting or entity' which is why it cannot 'exist meaningfully separate from the participants that inhabit it, and the situated context in which they (and the space) are operating' (p. 31). She further argues that 'meaning-making occurs through the activation of space by our bodies. As part of this framing, space and its occupation are not separate or in a behaviourist stimuli-response relationship, but endlessly informing and influencing each other' (p. 6). According to Boys, the encounters with and in learning spaces are neither cerebral nor corporal but affective, where affect is understood as a form of thinking that often takes place indirectly and non-reflectively. Thus space becomes an instrument for thinking about the world and a means for embodying thought into action. The complexity of

the relationship leads Boys to suggest a new theoretical framework for examining the relationship between space and occupation, based on the spatial triad by the French philosopher Lefebvre. I will return to this framework later in this chapter.

In a research project called 'Creating School Buildings', Kirkeby (2006) operates with a similar understanding of the relationship between the physical environment and its users as interdependent and non-causal. She emphasises that it is an interaction, which means that the school building is neither a neutral frame nor a deterministic catalyst for certain activities, but a co-player that constantly intervenes in and affects the school day. Like Mulcahy et al. (2015) and Boys (2011a), Kirkeby (2006) claims that the physical design can make a difference, but that a certain design does not automatically lead to certain behaviours and learning situations. Instead, the use depends on the recipients. These claims are substantiated through an examination of several schools, which then leads to the definition of a set of design principles for future building practices.

The same non-causality between space and practise is emphasised by other researcher, e.g. Ellis and Goodyear (2016). They claim that the structure of space alone is insufficient to achieve changes in the interactions of participants in the space and the effects of space on outcome are therefore mediated by other factors. This corresponds with Woolner et al. (2012), who suggests that the physical environment is part of a 'dynamic web of cultural and social aspects within which the environment needs to be appropriate to the intended teaching and learning undertaken in the setting' (p. 3).

Based on similar insights, Gislason (2018) argues that discussions about a school's design has to focus on more than just architectural issues like the physical layout. The physical design is only one of several elements that feed into the learning environment and these elements should all be considered in order to understand the relationship.

As the research presented in this section illustrates, the relationship between space and practice is complex and interdependent. Although some research suggests that a change in the physical environment can initiate or support change, according to Woolner et al. (2018) the results of such environmentally-led changes are mixed. Learning spaces can be changed quite dramatically without causing a change in the pedagogical practice. As Blackmore et al. (2011) emphasise, buildings alone are not

enough to change practice; 'it is all about relationships and changing cultures and practice' (p. 37). For this reason, according to Blackmore et al. (2011), newly built spaces will not move teachers to innovative pedagogies unless they are prepared and provided with the necessary skills, tools and resources to change their practices. This dilemma will be elaborated in the following sections.

FROM SUBJECT-OBJECT TO AN ACTOR-NETWORK RELATIONSHIP

The understanding of the interplay between space and practice, as presented in the previous section, draws on a social-constructivist ontology, where subject and object exist simultaneously and in relation to each other. In terms of learning environments, this means that neither space nor activity stands alone. Instead, the learning environment is understood as a social construction that emerges in the relationship between different elements such as the physical design, the users and the school organisation. In particular the Actor Network Theory (ANT), whose main figures are Bruno Latour, Michel Callon and John Law, is highlighted by many researchers within learning spaces as a theoretical approach to exploring the relationship between the physical space (and its design elements) and the use and the users (e.g. Boddington & Boys, 2011; Gislason, 2018; Kirkeby, 2006; Mulcahy et al., 2015). Moreover, ANT also links to participatory design and thus has relevance in relation to participatory design of learning spaces. According to Storni, Linde, Binder, and Stuedahl (2012), ANT offers new perspectives on and ways to rethink participatory design theories and methods, e.g. concerning the relational nature of the actors (designers, users and objects) as equals in the design process.

In the following, I will elaborate on ANT in relation to learning space research, based mainly on Latour (1996, 2005) and his theories, as well as Kirkeby (2006), Mulcahy et al. (2015) and Gislason (2018), who use the actor-network perspective on the field of learning space research.

ANT is a theoretical and methodological approach to social theory, developed by researchers from both science and technology studies (abbreviated STS) and

sociology, which treats the social and natural world as a constantly shifting network of relationships involving different actors. According to Latour (1996, 2005), ANT aims at describing the very nature of societies, and its origin can be found in the need for a new social theory adjusted to science and STS. Contrary to conventional sociology, which is concerned with the social relationships of individual human actors, ANT is interested in the study and description of human as well as non-human actors as they engage in networks. It focuses on how relationships that are simultaneously material and semiotic, come together to act as a whole in a world, where everything from object and process to human is equally important in creating social situations. In ANT, Latour (1996) says, there is nothing but networks and nothing exists in between the networks.

A main concept in ANT is the actor, which includes not only human individuals but also non-human, non-individual entities (Latour, 1996). Latour describes the concept as a semiotic definition of 'something that acts or to which activity is granted by others' (p. 373). This implies that the actor can refer to literally anything as long as it is assigned to be the source of an action. This action is not limited to something humans do, but also refers to the actions performed by a hammer, a kettle, a knife, locks, soap and many other things, as explained by Latour (2005). In addition, an actor is not understood as a fixed entity, but as flows and circulating objects undergoing trials whose stability and continuity depend on other actions and trials. Actors are constantly engaged by other actors and they constantly engage others by 'providing controversial accounts for their actions as well as for those of others' (Latour, 2005, p. 47). This means that the actor is made to act by others and also mediates the actions of others.

The actor can be anything that changes 'a state of affair by making a difference' (Latour, 2005, pp. 46, 71). The kettle, for instance, makes a difference, when you want to boil water. I would argue that the same applies to a learning space setting, which makes a difference in the actions of teaching and learning. However, as Latour emphasises, the actor does not determine a specific action, but can propose a lot of different actions depending on the other actors in the network. This means, according to Latour, that 'there might exist many metaphysical shades between full causality and sheer inexistence' (p. 72).

Latour proposes the notion of human and non-human as a substitute for the dichotomy of subject versus object, which has otherwise dominated the modern (and realist, to use Mulcahy et al. (2015)) discourse. The subject-object dichotomy separates everything into opposite poles, i.e. subject versus design or space versus practice, whereas ANT considers everyone and everything as an actor with an equivalent status in a world of relationships. Together, these relationships form a complicated, ramified network with as many dimensions as relationships, where there is no a priori order or hierarchy. In correlation with learning spaces, this means that neither space nor user stands above the other in a hierarchical relationship, but each informs the other in a mutual relationship, collaboratively generating the learning environment.

According to Boddington and Boys (2011), the reason why many current researchers on learning spaces draw on ANT is that it incorporates both human and non-human conditions into its framework, which ensures that an analysis will capture a detailed contextual understanding. Seeing space and practice as a mutual relationship or, in ANT terms, a network, offers less deterministic causal accounts of change and the effect of space on practice. Mulcahy et al. (2015) explain how ANT challenges the idea of space as fixed and absolute in favour of a view of space as open, unfinished, multi-faceted, relational and always in the process of becoming. Space is no longer a container or product for human activities, but is made through action and relations— or in ANT terms, as proposed by Mulcahy et al.: 'it is a sociomaterial enterprise of network making' (p. 580). This approach, which pursues a non-dualist analysis of the space-pedagogy relationship as space is treated from a relational, socio-material perspective, is accentuated by Mulcahy et al. as promising for the field of learning spaces.

I have found both the relationalist perspective and ANT to provide a theoretical understanding and foundation for the research performed as part of this PhD project. In the design experiments of the project, space and practice are understood and examined according to the relationalist perspective as relational, interdependent and in a constantly dynamic interplay. This brings attention to the process and the interrelation rather than merely considering practice and space as independent elements. As such, I build on the learning space research presented in this section.

Furthermore, the project draws on ANT in its framework as it understands and examines the spatial design and practice as mutually dependent actors in a complex network where many actors affect the process of change in a new school building or re-building project. This will be elaborated in the following.

THE PROCESS OF DESIGNING SCHOOLS AS A MEDIATION FROM INTENTION TO PRACTICE

ANT and Latour has inspired many researchers in learning space design, including me. However, Latour himself has not been directly engaged in this research field. In the following, I will refer to an explanation and elaboration of Latour's theories on hybrids and mediation by Kirkeby (2006), who has used Latour to examine the space-practice relationship and the process of building schools. I will then use her reading of Latour to point out a dilemma and suggest further elaboration in regard to the process of building and implementing learning spaces.

Kirkeby is strongly inspired by Latour and his view on the relationship between different entities and matters. She emphasises in particular Latour's thoughts on hybrids and ways to mediate between different actors as a theoretical perspective on the process of building schools and a way to analyse what architecture is and does.

Kirkeby explains how the division of the world in dichotomies and, in particular, the object-subject dichotomy is replaced by an idea of symmetry by Latour. In this perspective, the in-between the object pole and the subject pole will no longer be a gap but a continuum, where a myriad of hybrids of culture and nature exist. In Latour's view, the world consists of hybrids of culture and nature that act in-between rather than opposing subjects and objects. This even includes the human body. These hybrids are not just simple intermediaries transporting meaning or force without transformation but are assigned an independent, active role by Latour as actors in the networks of mediators they are connected to. They are mediators with the capacity to 'transform, translate, distort, and modify the meaning or elements they are supposed to carry' (Latour, 2005, p. 39). In this sense, I propose that a learning space can be understood as a mediator as it never just transports the design intention directly and

unchanged to the users, but allows for many experiences and uses.

According to Kirkeby, Latour rejects the division between subject and object in favour of the concepts of humans and non-humans as equal actor in networks to mark the juxtaposition of persons and things. Human interactions are kept together by non-human actors, artefacts that have been designed to take over functions and define borders for gestures and social interaction. An artefact, for example, can mediate between an intention, action or knowledge, embodied in the design by the creator of the artefact, and the user. In this process, the creator of the artefact presumes a series of competencies in the user and pre-inscribes this ideal user in the artefact. Moreover, the artefact can work as a social agent that takes over the role of a living actor and regulates human action. This, for example, relates to school architecture, where the architecture and the design can control or influence certain actions, e.g. through fixed furniture, locked doors or particular design layouts.

According to Latour, mediation can happen in several ways. Building on Latour, Kirkeby lists three types of mediators to create connections between separate entities, such as architecture and practice, which she proposes can be used to analyse architecture (pp. 144-145, 155):

- Transporters of knowledge (mediators can transport knowledge from one medium to an other);
- Programmes of actions can be designed into artefacts;
- 'People' (humans or human conditions) can be represented or re-presented into another medium.

Kirkeby explains how these mediators can be used to examine the relationship between architecture and practice, i.e. how the building program or pedagogical intentions (programs of action) are concretised in the physical building. This is relevant for my research project, where the design experiments, amongst other things, examine the process of transportation of programs of action.

Kirkeby regards the process of producing school buildings as a process of translating or mediating pedagogical intentions into reality. She explains this process as a series of intermediating stages from intention over program, design and building to everyday life (pp. 144-145), as Figure 1 shows.

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┌────────────────────────────────────────────────────────────────┐
: INTENTION  >  PROGRAM  >  DESIGN  >  BUILDING  >  EVERYDAY LIFE :
└────────────────────────────────────────────────────────────────┘
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Figure 1. Mediation diagram adapted from Kirkeby, 2006

The diagram visualises the transport and transformation of content from one medium to another in the process of moving from intention to realisation. Kirkeby emphasises that the diagram only visualises the process of transport and that it should not be considered as a simple manual or a picture of the creative process as such. She also points out that the many techniques and artefacts collectively forming the everyday life of the school cannot be looked upon as a simple equation—rather they interact or 'telescope', to use Latour's expression, in an ingenious, widely ramified actor-network that together constitute the everyday life of the school (Kirkeby, 2006).

Based on my relationalist perspective on the space-practice relationship, which is theoretically anchored in design, I suggest an additional link in the chain of the process (Figure 2), where the interplay between the physical environment and practice is actively developed and explored to mediate between building and everyday life—or space and practice, to use the terms in this thesis.

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┌────────────────────────────────────────────────────────────────┐
: INTENTION > PROGRAM > DESIGN > SPACE > ACTIVATION > PRACTICE :
└────────────────────────────────────────────────────────────────┘
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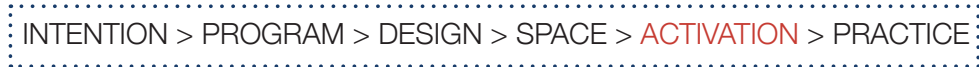
Figure 2. Diagram of the mediation from intention to practice with an additional link of activation

In this addition, with the activation process, the physical environment is assumed to be activated and adjusted to match practice and vice versa. This will be explored and elaborated later in this chapter and in chapter 5.

SPACE MATTERS
—LOOKING AT THE IMPACT OF SPACE

Before discussing activation of spaces any further, I would like to return to the physical design of learning spaces and the impact of design on practice. If we subscribe to the relationalist perspective suggested by Mulcahy et al. (2015), where space and practice are understood to be generated together, and if we presume that both space and practice are actors in a complex network as proposed by ANT, then neither space nor practice can be addressed separately when examining the relationship nor can anyone be ascribed a more significant role in the relationship. Still, research in learning spaces has been dominated by a strong focus on the material aspects of the physical design and a common assumption has until recently been that space can change practice, according to Mulcahy et al. (2015). In addition, this view is still found to dominate current school building practice. But what then is the actual role of space in the relationship between space and practice?

As mentioned earlier, research by Woolner (2010), Cleveland (2011), Kirkeby (2006) and Byers et. al. (2018a; 2018b), amongst others, indicate a connection between certain spatial designs and certain pedagogical practices and activities. As a way to explain the relationship between the physical space and the pedagogical intentions behind the spatial design, Torin Monahan (2002) proposes the concept of 'Built Pedagogy' and defines it as 'architectural embodiments of educational philosophies' (p. 5). The concept is based on the belief that the physical classroom space is linked to and embodies specific pedagogical practices, thereby shaping student learning experiences and behaviour (Byers et al., 2014). It is the ability of the cultural, psychological and behavioural attributes of the physical space to shape teaching and learning. This means that a traditional teaching approach is more likely to be conducted in a traditional teacher-centred classroom setting where all tables and chairs face the teacher's desk in front of the interactive whiteboard than a student-centred approach. According to Monahan,

...built pedagogies operate along a continuum between discipline and autonomy. On the disciplinary side, they can restrict learning possibilities by not allowing for certain movements or flows. For example, desks bolted to the ground make flexible interpretations of spatial use extremely difficult, and they impose directions for how space should be used. In the middle of the discipline/autonomy spectrum, there are built pedagogies that enable but do not require flexible behaviours: movable partitions and desks illustrate space left open to interpretative use. Finally, on the autonomy end, open classrooms invite and almost demand that individuals appropriate space to their perceived needs. (Monahan, 2002, p. 5)

Thus, the particular affordances of a space send messages to the users about appropriate behaviour and use. Although all physical spaces can be changed, fixed spatial designs demand more energy from the users in regard to changing the setting than a flexible environment. What is more, as Rivlin and Wolfe (1985) explain, 'it is rare for a person to move a chair once it has been placed—even in one's own living room' (Rivlin & Wolfe, 1985, p. 7, quoted in Woolner et. al, 2007, p. 62).

This means that although a spatial design does not dictate pedagogical practice, research indicates that the design of a learning space does potentially influence practice and can be either very restricting or supportive. In a study by Byers et al. (2018a), the spatial transformation from traditional to new types of learning environments was found to contribute to changed practice and improved academic achievements. However, this was also linked to the mediating influence of the teachers and their ability to exploit the additional affordances of the new environments for pedagogical benefits. Change happened in the mutual relationship between space and practice.

According to both Gislason (2007) and Kirkeby (2006), the architecture of a school conveys strong messages about how to think and act, which is why social patterning and learning processes are intimately connected to the material context. Gislason (2007) claims that learning is formed within its social-material context, which is why a learning environment should support dynamic learning processes both materially and socially. However, this does not necessarily happen in every learning space layout. Therefore, Gislason argues, it is important to consider how a learning space works as a pedagogical instrument (2007). Kirkeby (2006) likewise argues that physical spaces

can structure different types of meetings or appeal to certain activities through its layout and setting, as well as regulate behaviour through its physical appearance and for instance prevent certain types of actions. Returning to the discussion about Latour and mediation in the previous section, this means that the space mediates the intentions of the creators behind the spatial design and as such becomes a social agent.

In summary, space does not change practice, but space can become a social agent and a mediator of intentions and as such affect practice, according to the researchers presented in this section. This is also the assumption on which this research project builds. I believe that the configuration of a space has the potential to support different types of activities (by providing a supportive setting) and work as a tool for the users of the spaces. However, this does not happen on its own but depends on the users, which will be elaborated in the following section.

ENVIRONMENTAL AWARENESS AND COMPETENCE

> *When teachers realise they have control, they can feel empowered by the same environment that once would have defeated them. (Martin, 2002, p. 154; Martin, 2004, p. 87)*

Martin (2002) claims that there is a need for teachers to learn how to question their physical environment in a constructive way and proactively look for redesign solutions in order to feel in control of and be empowered by the spatial settings. In a study on the classroom environment and its effect on the practice of teachers, Martin found that the layout of the classrooms reflected the teaching practices. Most teacher-centred lessons were taught in a horse-shoe or row setting, whereas child-centred lessons took place in multiple activities facilities. This finding led Martin to speculate 'whether teacher-centred teachers create row type classrooms or whether row type classrooms lead teachers to teach in a teacher-centred mode' (p. 147). Furthermore, she found that teacher-centred teachers tended to believe that the physical space did not impact their lesson planning, whereas child-centred teachers believed it did,

both positively and negatively. Teachers using a balanced pedagogy tended to believe the space had a positive impact on their planning. The teachers who questioned their own setting more were also the ones less satisfied with their classroom environments which, Martin notes, seems to be a first step towards change and empowerment of the teacher. If the teacher does not recognise the role of the physical environment, change is unlikely to occur.

Martin (2002; 2004) concludes that there is a relationship between the physical environment and the teacher's pedagogy, which the teachers should be aware of. This awareness should be deliberately developed in the teachers, which is why she calls for 'environmental awareness and competence' to be part of teacher training and continued professional development. Martin (2002) explains environmental awareness as understanding how the environment relates to human activity, whereas competence means knowing how to redesign the environment to fit teaching practices. By linking awareness and competence, teachers can overcome passivity, make active choices and experiment with a variety of spatial alternatives, which, according to Martin, will enable them to challenge and develop their environment to fit individual requirements. An arranged environment can be used as a deliberate teaching strategy that complements and reinforces other strategies to support children's learning (Martin, 2004).

A similar call for teacher environmental competence is put forward by Lackney (2008), who explains the concept as 'the ability to understand and effectively use physical instructional space for pedagogical advantage' (p. 133). Similar to the definition by Martin, this includes both awareness of the physical environment and its impact on activities and the ability to use and alter the environment in relation to goals and activities. According to Lackney, the issue of how and to what degree teachers understand and use space in their practice continues to receive limited attention in educational research. He further claims that educators in general lack the competence to effectively use the physical environment to support their practices as well as a common language for discussing their environmental experience and concerns in relation to practice (2008).

Lackney suggests three types of factors as contributing to the lack of environmental

competence, namely individual factors (e.g. lack of training, passive resignation or fear of reversibility), social factors (e.g. norms of acceptability or turf issues) and organisational factors (e.g. unilateral decision making, limiting rules or lack of resources). He claims that the impact goes both ways: while a lack of environmental competence is a consequence of more of these factors, the teachers' awareness of and ability to use the environment also affects the school at the individual, social and organisational levels.

In a study on teacher environmental competence in elementary school environments, Lackney attempts to raise the environmental competence of a group of teachers from five schools by using an action research approach. His study consists of three stages, starting out with semi-structured interviews and observations to initiate an examination of the teachers' assumptions, moving on to semi-structured workshops to identify the teachers' environmental concerns and finishing off with a final case report to each student principal, describing the results and offering to continue the process to developed strategies for further action. The process of the study aims to address the three types of factors presented earlier—individual, social and organisational. In the initial interviews, the teachers were quite unaware of the impact of the physical environment on practice. Following the workshop training, the teachers exhibited a higher level of awareness some of which had come spontaneously (mostly relating to immediate experiences such as adaptability and sensory stimulation, e.g. thermal comfort and air quality), whereas others had to be prompted by the workshop facilitator (e.g. aesthetics, appearance, personalisation and ownership of the environment). Only a few teachers were able to articulate problems and come up with alternative solutions and very few were motivated and prepared to act to improve their conditions. This, according to Lackney, proves the need for teacher training in the necessary skills to make spatial adjustments—or, as Martin (2002) puts it, move from awareness to competence.

Teacher training, however, demands organisational support, which Lackney's study also exemplifies. Despite being handed an action plan, none of the school administrations took much action to support and train their teachers further in developing environmental competence. According to Lackney, this illustrates how the

problem of environmental competence not only concerns the individual teachers but the entire organisation of the school.

Inspired by Martin (2002; 2004) and Lackney (2008), the design experiments in my research project address the dilemma of environmental awareness and competence of teachers in different ways. In the first experiment, the awareness and competence of the teachers are considered passively by observing and analysing how the new space is used, whereas the two following experiments work more actively with potential means and ways to train the teachers in environmental awareness and competence. I will return to this in the analysis of the experiments and the following discussions.

PARTICIPATORY DESIGN OF LEARNING SPACES

Architects and designers tend to complain about teachers being conservative when it comes to changing space and practice (Parnell et al., 2008; Woolner, 2010). This leads to new types of learning spaces being used in a traditional manner against design intentions and affordances. However, another explanation than teacher conservatism could be lack of environmental competence, which I suggest can be linked to a lack of participatory (teacher) involvement in the design process.

Woolner (2010) argues that 'it seems less likely that teachers left out of a design process will be able to or willing to adapt their teaching once they are managing the new or altered environment' (p. 66). Her response to this is that the participation in the design process can make users appreciate general ideas about the use of space and understand the particular case of their school environment. Furthermore, she suggests that user participation will affect far more than the use of the space as 'it seems likely that any impact of participatory design on teachers will also be seen in the content and the style of their teaching, not just in how they arrange their room or cope with a new building' (p. 46). Woolner therefore proposes the participatory design process as a springboard to encourage both teachers and learners to become more thoughtful and involved users of their environment. Returning to Martin (2002) and Lackney (2008), the participatory design process thereby becomes a means to

developing environmental awareness and competence in the participating teachers. In my opinion, this is especially likely to happen if the teachers are invited to become co-designers of their new learning spaces and as such become involved in the actual process of designing rather than acting as mere informants. Leaning on Nordquist and Watter (2017), who state that participation in the design process contributes to a feeling of ownership, motivation and empowerment among the end users, I propose that user participation will contribute to a better alignment of space and practice, as teachers are more likely to take control of the learning environment when feeling motivated and empowered.

According to Nordquist and Watter (2017), teacher involvement in the design process also provides genuine knowledge to the designers on how the classrooms work, which will be a guarantee for the alignment of curriculum and space. Similarly, Woolner (2010) points out that teachers can help foresee genuine difficulties with a design idea because they are closer to practice. She also proposes that involving the users in discussions about current, future and desired usage should lead to more appropriate and well-fitting design since there seems to be no complete answers to what constitutes an ideal learning environment. Parnell et al. (2008) expresses similar thoughts when suggesting that participation provides the teachers with the possibility 'to create spaces to which they can contribute, understand, control and use effectively in the future' (p. 220). Furthermore, Parnell et al. (2008) explain that teachers might be more forgiving about the things that do not work so well if they have participated in the designing.

As a critical comment to the participatory perspective presented in this section, I would like to question the level and type of participation proposed, as this is not always explicit in current research. For instance when Nordquist and Watter (2017) talk about participation as a means to providing genuine knowledge to the designers, this sounds more like the teachers being assigned a role as informants rather than co-designers or co-creators in the design process. Therefore, I would like to highlight the notion of 'creating spaces', as proposed by Parnell et al. (2008), as it suggests a genuinely collaborative design process, where the users of the school and the designers work together to design the new learning spaces in a genuine 'partnership' (Arnstein, 1969).

This level of participation is, according to Shelley Arnstein (1969) and her 'ladder of citizen participation', amongst the highest levels of participation in a participatory process. In Arnstein's ladder, participation ranges from non-participation (i.e. manipulation) through tokenism (i.e. information and consultation) to citizen power (i.e. partnership and citizen control). In relation to learning spaces, a partnership level means that the teachers are not just informants providing information to the designers, but take part as genuine participants in co-creating the new environments. This will benefit the future use of the building, with the usage understood 'as a dynamic, ongoing relationship between people and setting', as proposed by Woolner (2010, p. 53).

Challenges and issues in participatory design processes of learning environments

Many studies illustrate the value of user participation in the design of new physical learning environments (e.g. Blackmore et al., 2011; Koutamanis et al., 2017; Könings et al., 2017; Sigurðardóttir & Hjartarson, 2016; Woolner, 2010, 2015) and participation is claimed to be beneficial in order to account for the different expectations and perceptions of stakeholders. However, as Könings et al. (2017) point out, much remains unclear about how to involve the users in the complex design processes. Generally, most participants in participatory processes are not trained in design or design research and come with their own disciplinary tools, methods and mindsets (Sanders, 2013). This might limit the participatory process and places demands on the planners and facilitators of the processes to create a common platform and collaborative tools to work with.

A continuing challenge in participatory design of learning spaces is the discrepancy between the makers of the built environment (architects, designers, engineers and other professionals) and the users of the environment (school management, teachers and students). Participatory processes often involve a wide range of professionals from education, architecture, design and construction, who all have differing viewpoints, assumptions and expertise (Janssen et al., 2017; Woolner, 2010). These different

backgrounds potentially produce tensions because of different or conflicting views and motivations (Parnell et al., 2008; Woolner, 2010). Hence, a key challenge to user involvement is the clash of professional cultures and possible lack of understanding and respect for the professional knowledge of other participants (Woolner, 2010). Another challenge is the lack of a common language dealing with design, construction and pedagogy, which makes the communication between the different professions complicated (Parnell et al., 2008; Woolner, 2010). The solution lies in dialogue, Woolner (2010) claims, which might be achieved through a genuinely collaborative participatory process. Further challenges in participatory processes relate to organisational issues, such as procurement methods and protocols within which the process occurs and which might bring their own constraints as well as time and resources (Parnell et al., 2008).

Based on interviews with twenty architects and facilitators of design processes, Parnell et al. (2008) claim that it can be especially challenging to involve the teachers in the design process. Their research shows that for participatory processes to work, teachers need to feel involved and have to be assigned a specific role within the process that specifically relates to their knowledge of school life and values their potential to match space with current and developing practice (as cited in: Woolner, 2010, p. 65). Furthermore, genuine commitment of practicing teachers in a school change is often limited by the many demands placed on the teachers. Therefore, Woolner (2010) suggests that funding should be budgeted to pay for an on-going commitment of the teachers.

Both Woolner (2010) and Koutamanis et al. (2017) recommend visual tools as a beneficial way of collaboration between different stakeholders. In general, visual tools are often part of a toolbox in participatory design as they are experienced to help initiate discussions and explorations of possible futures and designs. The tools used in participatory design processes are, according to Brandt, Binder, and Sanders (2012), very important for the final accomplishments of the participants and should be adapted to both users and process goals. I will return to the participatory design approach and tools in the following chapter of this thesis, where the research methodology and methods of this research project are presented and discussed.

According to Janssen et al. (2017), the development of methods for effective engagement of non-designers in design activities in participatory educational design is still in its early stages. Relating to the many school building projects initiated worldwide in recent years, more research on the matter of user involvement in learning space design is therefore needed.

FROM USERS OF SPACES TO MAKERS OF SPACES

I have often experienced a discrepancy between the intentions translated into physical learning space designs by the designers and architects and the realities of the space-in-practice. This is even the case in the first experiment of this research project. Returning to the diagram by Kirkeby (2006), this indicates that something 'goes wrong' in the process of translating intentions into actual use—or that we should look at the relationship between intention and use from a different perspective.

In a previous section of this chapter, I proposed that an additional link in-between building and everyday life should be added in Kirkeby's diagram as a means to help intention become lived practice. This changed the series of mediation to:

INTENTION > PROGRAM > DESIGN > SPACE > ACTIVATION > PRACTICE

Figure 3. Diagram of the mediation from intention to practice with an additional link of activation (equal to Figure 2).

However, this addition is not considered as a phase of merely teaching the users how to use the space according to intentions. As the research previously explored in this chapter indicated, space and practice mutually inform each other, which assigns the user an active role in activating and reconfiguring learning space designs. This corresponds with the perspective on the space-practice relationship and the user as considered through an ANT lens.

In an article from 2015, Jamie Wallace questions the term 'user' in relation to the way we interrelate with technology. According to Wallace (2015), the term

'user' implies that the thing being used (in his case, technology) is a finished and prescribed artefact, which the user has to learn to adopt as the designer intended. This reductive conception ascribes the user to a passive role and 'prevents any view of how technological-human relations rely upon moments of material interaction, and it says little about the creative aspect of such interactions necessary for any technology to successfully contribute to human practice' (p. 99). Instead, Wallace suggests that we should conceive of users as equally makers (of technology) and stresses the transformative actions of our everyday practice:

> It is only once technology is materially engaged within a context of human practice that claims and expectations about the promises of technology become explicit. Without this human element, any understanding of technology remains a prescribed technical specification constructed during the design process. (Wallace, 2015, p. 102)

To explain this interrelationship between technology and human practice, Wallace uses the concept of affordance developed by psychologist James J. Gibson in 1979. The term 'affordance' is proposed by Gibson (1979) as a means to describe the mutual relationality between an animal or organism and its environment, which constitutes the foundation for perception and action (Wallace, 2015). According to Gibson (1979), the affordances of an environment are what it offers the animal, meaning what it provides or furnishes, for both good or bad. Gibson uses the example of the physical properties of a surface, which can be shaped in such a way that it affords support for a certain species of animal. Despite being physical properties, these affordances of support cannot be measured objectively as in physics, but have to be measured relative to the animal and its specific properties, e.g. size and weight. The same physical properties of a surface will afford something completely different to another species of animal. The notion of affordance therefore refers to both environment and animal—or object and subject—as it implies the complementarity of both:

> An affordance cuts across the dichotomy of subjective-objective and helps us to understand its inadequacy. It is equally a fact of the environment and a fact of behaviour. It is both physical and psychical, yet neither. An affordance points both

ways, to the environment and to the observer. (Gibson, 1979, p. 129)

Wallace (2015) explains affordances as opportunities for makers as well as users 'for action through a perceived ability to act on what is sensed. It isn't simply seeing a feature, but a future way of making use of that feature' (p. 109). This means, according to Wallace, that affordances are not just linked to attitudes of bodily engagement but are part of a cyclic relationship between maker and environment 'in which the making process both relies upon and changes the affordances constituted at any time' (p. 109). By relating affordances to actions of making rather than use, Wallace claims to reveal them as 'disruptive, changeable, elusive, capricious, inarticulate, and enacted during situations of practice', rather than predetermined through processes of design (pp. 99-100).

In relation to technology or, as is the case in this research project: learning space design, this means that the technology or design is not to be considered as a finished product but as a material with which the user/maker engages and which is constantly enacted in practice. By defining users as makers, as Wallace does, design and use are coupled and acknowledged as being in a constant state of interplay and mutual influence, and the notion of the user is attributed a creative dimension as equal makers of the technology or design.

The anthropologist Tim Ingold (2013) expresses similar thoughts on design as an ongoing process of making, when he claims that a designed object does not achieve its end just by being manufactured, but becomes through its use. The world, he says, is constantly constructed by the way of activities of its inhabitants and things are never finished, meaning that there is no 'true' way to use a designed object. At the same time, Ingold claims, 'every object of design sets a trap by presenting a problem in the form of what seems to be the solution' (p. 62). This means that designed objects, by offering us a solution to a problem, attempts to determine our actions and exclude other ways of doing an activity. A chair, for instance, deceives us into thinking how we have to sit—upright, on the chair, with our feet on the ground—rather than squatting or lying on the floor. Relating to the design of a learning space, I would argue that this means that the setting (the furniture and artefacts of the space and the way they are placed in

the space) will be experienced as supportive of certain practices and excluding others. In some cases, this might end up determining the activities taking place if the users are not aware of this dilemma and have the competence to actively use and redesign the space to match practice, as discussed previously in this chapter.

Mulcahy, Cleveland, and Aberton (2015) resort to the same idea of making in relation to learning spaces when suggesting that we should think of the term 'learning spaces' as a verb rather than a noun, meaning something we do (a matter of encounter) rather than something we have (a finished learning space design) (pp. 590-591). Their argument is that such an approach would afford acknowledgement of the multiplicity and mutability of the spatial and pedagogical practices which are otherwise limited in existing empirical research.

Inspired by Wallace (2015), Ingold (2013) and Mulcahy et al. (2015), I propose that the users of learning spaces are equally to be regarded as makers of the spaces and that learning spaces are to be regarded as something we do rather than a finished product, which the user passively adapts to. In this sense, every teacher becomes a designer, as Martin (2002) suggests, 'responsible for preparing the environment to achieve his or her educational purposes' (p. 154). This, however, demands that the teachers possess the previously discussed environmental awareness and competence in order to be able to actively make use of the spatial affordances. To avoid getting trapped in a passive relationship to the learning space, I therefore suggest that more focus is directed to the significance of teacher training in environmental awareness and competence, for instance as part of the participatory design processes of new learning spaces.

Using Gibson's theory of affordance on the relationship between space and practice means that the affordance of the learning space design is to be measured relative to the user (or maker) because each user (teacher as well as student) differs from the other. This implies that a learning space is not to be regarded as a fixed spatial solution; rather it may resemble an organism that evolves and changes with the users—or, to use Latour, as an actor in a network, where each part informs the other. Therefore, design and use cannot be separated, because it is only once the spatial design is materially engaged within a context of human practice that it comes into existence. This assumption corresponds with research by Barrett and Zhang (2009), who note

that a variety of teachers and students—all of them different—will inhabit and inherit a learning space design. Therefore, when a new learning space design is completed and handed over to the users, it can only be a finished beginning in which adaptations and changes will occur (Blackmore et al., 2011). Returning once more to the adapted mediation diagram in Figure 2 and Figure 3, this is where the activation link in the diagram comes into action as a dynamic and never-ending interaction between design and use. I will return to this in the discussion of the experiments.

In the following, I will continue to use the term 'user' instead of 'maker' for reader-friendliness. In the context of this thesis, 'user' mainly refers to the teachers and the students, whom I consider to be the main inhabitants of learning spaces. However, in the remainder of this thesis the notion of 'user' refers to a fusion of 'user' and 'maker', as discussed above, because the user of a learning space is believed to be an active participant in the activation and reconfiguration of the physical spatial design.

TOWARDS A FRAMEWORK FOR ANALYSING RELATIONSHIPS BETWEEN SPACE AND PRACTICE

As this chapter demonstrates, the interplay between space and practice is intricate, dynamic and dependent on a variety of social and material factors. This leads me to question how to examine and analyse a relationship of such complexity.

A number of researchers have attempted to frame and answer this issue by proposing different variations of an analytical framework through which the space-practice relationship can be examined. Overall, these frameworks or 'learning environment models', as Gislason (2018) calls his model, have many similarities but also differences, which I will elaborate on in the following. Finally, I will use the comparison to establish a new learning environment model, suitable for examination and analysis of the design experiments performed as part of my research project.

In an attempt to rethink the relationship between space and practice in post-compulsory educational institutions, Boys (2011a) proposes a framework for analysis based on the 'spatial triad' by Henry Lefebvre. In 'The Production of Space'

(1991), Lefebvre proposes a triad consisting of three elements—'spatial practice', 'representations of space' and 'representational spaces'—that merge in an ongoing production of the social space (Smart, 2008). According to Boys, Lefebvre's triad is developed as a means to conceptualise the relationship between space and the social element beyond the comprehension of space and society as transparently reflecting each other (Boys, 2011a). This view of space and society as more than a reflection of each other corresponds with the understanding of space and practice as a relationalist interplay rather than a dualistic reflection of opposing poles, presented earlier.

Building on Lefebvre, Boys proposes a learning space framework, consisting of three main aspects as depicted in Figure 4:
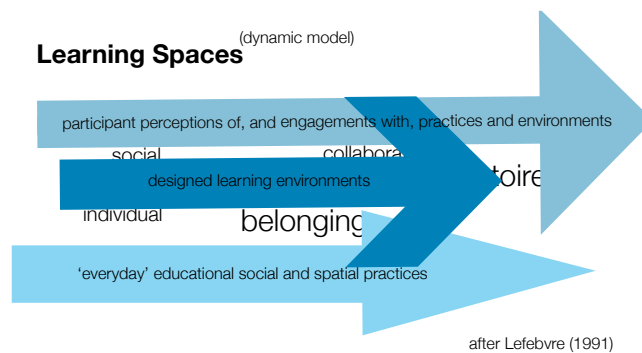
Figure 4. Approach for examining learning space by Jos Boys, adapted from the book Creative Learning Spaces*, p. 81*

The first aspect Boys addresses is called *'everyday' educational social and spatial practices*. This aspect covers the ordinary experiences and daily routines of existing communities of practice in education, which take place in relation to time and space. According to Boys, these are performed unconsciously unless something unexpected happens. Lefebvre calls this *spatial practice or perceived space*, which he claims shapes and produces the society's space by slowly mastering and appropriating it.

The second aspect Boys proposes is called *designed learning environments*, which refers to the conceptualised space of planners, scientists and other experts. This aspect often takes on physical forms such as maps, plans, models and designs, which are used to intersect the everyday social and spatial practices. This aspect builds on Lefebvre's

second element *representations of space/conceived space.*

The third aspect Boys calls *participant perceptions of, and engagements with, practices and environments.* This aspect refers to the way individuals can and do alter space in the process of appropriation, adaptation or transformation of the 'normal' social and spatial practices (Boys, 2011a, p. 80). Whereas the first aspect covers the overall social and spatial practices established by society (I understand this as e.g. policies or national educational goals), the third aspect refers to how people (users) individually engage with, adapt and change social and spatial processes and repertoires. Boys describes it as 'the spaces in-between', because it relates to both existing and specific social and spatial practices and the spaces in which these take place (p. 81). The third aspect builds on Lefebvre's third element, *representational spaces/lived space.*

The learning space framework is proposed by Boys as a method for examining learning spaces as a pattern of encounters and practices that opens up an understanding of the concepts of gaps, tensions and unintended consequences relating to the intersections between the aspects. The model of the framework in Figure 4 illustrates how the three aspects run in parallel with variable intensity and intersections. Sometimes they run closely, sometimes very far apart and sometimes they overlap. Boys suggests that we examine the intersections between the three spatial aspects in order to better understand the relationship between learning and space and that the aspects, if taken as partial and overlapping, offer a 'potentially rich conceptual framework for linking architecture and its occupation' (p. 80). She explains that the three aspects should be understood in a dynamic relationship and visualises this as three parallel arrows that overlap and interrelate in Figure 4. The aspects are always situated in relation to both places and people and the relationship between the aspects is dynamic and changeable in a constant flow towards and away from coherence and stability. Therefore, according to Boys, the aspects only momentarily align.

Similar frameworks for analysis of learning environments are proposed by Ricken (2010), Mulcahy et al. (2015) and Gislason (2018) as means to explore the relationship between space and practice. Based on years of practice in Rune Fjord Studio and current literature, a basic assumption in this research project is that the actual use of a learning space strongly depends on the coherence between the design of the physical learning

space, pedagogical practices and the organisation of the school. The assumption that a balanced learning environment requires a consistency between organisation, space and practice is shared by Winie Ricken (2010), who has examined the interaction between the physical space and pedagogical and organisational practices in four primary and secondary schools. In Ricken's terms the notion of 'physical space' refers to the interior design of the space (furniture) and the actual use of flexibility, whereas 'pedagogical practice' is the actual planning and practice of learning activities, including the use of the space. The 'organisation of the school' refers to the overall pedagogical goals and physical structure, which are asserted to influence both pedagogical practice and learning spaces by dictating time schedules, spatial organisation and flexibility (e.g. the size of the class, common areas and group spaces). Ricken especially focuses on the need for alignment of space, practice and organisation in order to create the best conditions for a balanced learning environment. In her opinion, if all three elements strive towards the same overall goals for the learning environment, they will support each other in a symbolical sense and work together to create a balanced learning environment. Hence, a conclusion by Ricken is that a good learning environment requires a correspondence between the physical space, pedagogical practices and the organisation of the school, which is illustrated in the learning environment model in Figure 5.
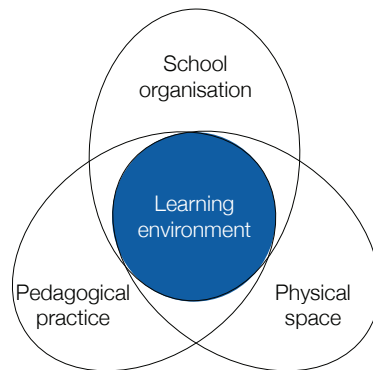
Figure 5. Adapted learning environment model by Winie Ricken from her
PhD thesis 'Arkitektur, pædagogik og sundhed', 2010 (DK), p. 138, translated from Danish.

Similar elements are stressed by Mulcahy et al. (2015), who claim that a learning space is a product of three heterogeneous relations or dynamics: a pedagogical vision (a

discursive dynamic), a design (a material dynamic) and a shared structure (a social dynamic) such as the organisational setup of a school. Thus, according to Mulcahy et al. (2015), a learning space is not just a physical building in which learning occurs; it is a product of interrelations and materially embedded practices.

Another model regularly referred to in research on learning spaces is the *school climate model* proposed by Gislason (2018) as a means to outline the social and architectural elements that in combination create a learning environment. Gislason's model (Figure 6) is slightly different from the others as it consists of four elements: Physical Design, Organisation, Educational Culture, and Student Dynamics.
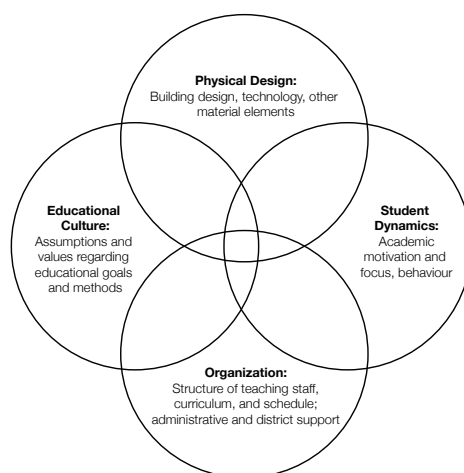
Figure 6. School Climate Model by Gislason, 2018 (based on Owen and Valensky, 2007)

In Gislason's terms, the physical design includes the material elements, information technology, aesthetic qualities, heating, lighting, ventilation, cooling systems and the physical layout of the school, whereas the organisation encompasses all aspects of how a school is organised, including structure, administration, daily schedule and the curriculum. His third element, the educational culture, refers to the educational assumptions and values that underlie the school program. This is similar to the pedagogical practices defined by Ricken (2010). Moreover, Gislason has added a fourth element to influence the school environment in his model, the student dynamics, which he claims plays an important role in learning environments. This is especially in relation to more open-plan facilities, which can be difficult to manage as they

encourage social activity and tend to have more visual and auditory distractions. According to Gislason, all four elements should be considered when designing new schools. The school climate model is therefore proposed by Gislason as a framework for communication between educators and architects to address organisational and design challenges from the beginning of the planning process.

Despite small variations in the definitions of the elements, the cited researchers all point to a connection between the spatial design of a school, the organisation of a school and the educational practices taking place in the school. In addition to these, Gislason (2018) proposes the student dynamics as a fourth element of influence on the school's total learning environment.

In the analysis of the experiments performed as part of my research, I mainly focus on the three common elements that are claimed to influence the interplay between learning space and pedagogical practice: the spatial design, the pedagogical practices and the organisation of the school. Although I agree with Gislason (2018) that student dynamics play an important role in a learning environment, I consider this element to be of a different character and to play a different role in the equation than the other three elements. In my view, the role of the student is not necessarily as influential as the other three elements in the relationship between space and practice. The pedagogical practice and the school organisation both control the use of the spatial design, while the spatial design can support or impede pedagogical practice (Woolner, 2010; Woolner et al., 2010) and complicate the organisation. Student dynamics play a part in this relationship, but are controlled to a larger extent by the other three elements. Coherence between practice, design and organisation is believed to foster the best conditions for learning and student dynamics, which is why I suggest the student learning situation as the focal point of the other three elements. Excluding the student dynamics from the analysis is also a way to limit the scope of this research project.

To visualise the connection between pedagogical practices, learning space design and the organisation of the school, I suggest a new learning environment model as displayed in Figure 7. The model builds on the previous models and spatial theories by Boys (2011a), Ricken (2010), Mulcahy et al. (2015) and Gislason (2018) as defined earlier

in this section and is proposed as a framework for examination of the relationship between learning space design and pedagogical practice in this thesis.
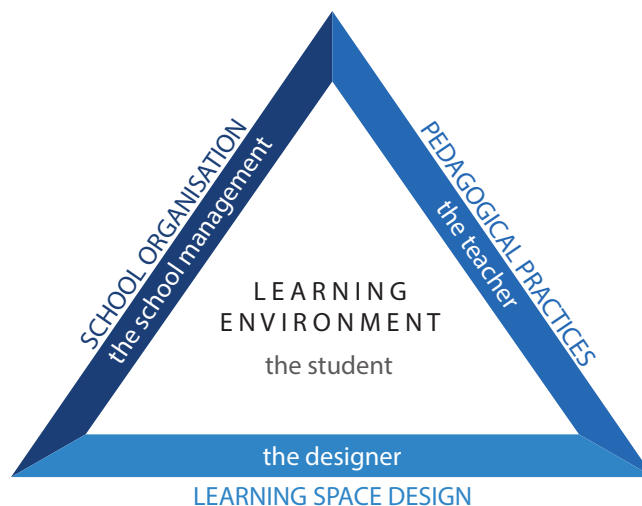
Figure 7. The learning environment triangle visualises how the alignment of learning space design, pedagogical practice and organisation of the school influence the learning environment

The relationship between the three main elements shaping the learning environment is visualised as an equilateral triangle, where the student and the learning environment is placed in the centre as the focal point of the relationship. The triangular shape is chosen as it visualises how each element depends on the others as actors in a network and that the balance of the relationship will shift, if one side increases or decreases in relation to the others.

The three elements in the model, practice, space and organisation, are inspired and informed by the elements proposed by Ricken (2010), Boys (2011a), Mulcahy et al. (2015) and Gislason (2018), which have been discussed earlier in this section. Therefore, I will refer to these without going into details in the following definition of the elements of the triangle.

The first element, the pedagogical practices, refers mainly to the individual planning and execution of teaching and learning activities and the actual use of the physical learning space. This understanding leans on the definition of pedagogical practices by Ricken (2010) as well as Boys' (2011a) third aspect covering the individual

perceptions of, engagements with and adaptations of learning spaces and practices. This is even similar to what Mulcahy et al. (2015) call the vision or discursive dynamic. The pedagogical practices also include educational assumptions and values, which Gislason (2018) calls educational culture. The teachers are the main executors of these practices and thus linked to this element in Figure 7.

The second element, the learning space design, is concerned with the physical design and similar to the physical space by Ricken (2010) and Gislason (2018). This is also what Mulcahy et al. (2015) calls the design or material dynamic. In my interpretation, the element mainly deals with the built environment, which includes the spatial layout, design elements and material elements such as heating, lighting, ventilation, acoustics, aesthetic qualities and IT-systems. Since the designers (and architects) are the main creators of the physical spaces, I have linked these two in Figure 7.

The third element, the organisation of the school, refers to the management of the school, which covers leadership as well as time schedules and administration of the physical school structure. These are the existing overall practices at the school. The element also covers the overall pedagogical goals (as proposed by Ricken, 2010) and the curriculum (Gislason, 2018). Boys (2011a) refers to this aspect as the ordinary routines of existing communities of practice in education, which is directed and decided a level above individual practice. In Mulcahy et al.'s (2015) terms, this is the shared structure or social dynamic. The school management is the administrator and controller of the school organisation, linked to the organisational element in Figure 7.

For reader-friendliness, I will mainly refer to the three elements as 'practice', 'design' and 'organisation' in the remainder of this thesis.

The triangle is fairly simple and not without limitations. For instance, it excludes other elements and stakeholders who influence and participate in the design processes of learning spaces and the construction of a learning environment. This, however, is not seen as a disadvantage in the context of this thesis. As explained earlier, I consider the three elements covered in the model as main constructors and influencers of a learning environment. Furthermore, I would argue that the teacher, the designer and the school management are the main parties that need to communicate in participatory design processes of learning spaces in order to create coherence between space,

practice and organisation.

Although I agree with Boys (2011a) that an alignment of the three elements, space, practice and organisation, is rarely obtained and then only momentarily relating to the constant dynamics of a living environment, I still suggest that coherence between practice, space and organisation should be continuously strived for by the designers, users (teachers) and school management. The alignment should be considered iteratively in the design process and attempted in the following appropriation of the learning spaces in order to create the best conditions for learning. Hence, I suggest that alignment is considered as an ongoing process and not a static condition.

The learning environment triangle is believed to be more suitable as an analytical tool in my research project than the existing models due to its combination of the elements, pedagogical practices, learning space and organisation with the actors (and controllers) of the elements—the teacher, the designer and the school management. The triangle has been used as an overall analytical framework to explore and analyse the three experiments. The analysis mainly consisted of looking at the data material (logbooks, emails, interviews, photos, observations etc.) through a socio-material perspective, searching for statements, actions or other references that link or relate to the three elements in the model and their interrelations. These were then used to create an understanding of the findings regarding the interplay between practice, space and organisation and how these inform the research questions. For the same reason, I concurrently refer to these three elements in the description and discussion of the experiments. The methodology, methods and data collection performed in this research project will be elaborated and discussed further in the following chapters.

I am aware that by selecting the learning environment triangle as my main analytical tool, I exclude other potentially interesting aspects of the relationship between space and practice. I am also aware that, as a participant in the experiments, I cannot avoid being a co-constituent of the relationship being examined e.g. through my workshop activities or interview questions as discussed in chapter one. Further discussions on the topic will also be conducted in the following chapter.

4 // A DESIGNERLY WAY OF DOING RESEARCH

Chapter 4 outlines the research design of the thesis. The chapter is divided into two parts of which the first part presents the overall methodological approach of the research project and the second part introduces the research methods and tool. The chapter starts out with a brief introduction to the design research tradition and research through practice, followed by reflections on my role as designer-practitioner-researcher. It then proceeds to explain the concepts of 'research through design', 'research through practice' and 'action research' and the relationship between these methodologies and this research project. The second part of the chapter presents the methods and tools used to conduct the experiments and collect as well as analyse the empirical data. The research approach is mainly constructive, experimental and programmatic as it constructs knowledge through design experiments. The main tools in the project come from a participatory tradition, but even methods from other scientific fields have been applied to collect data, such as observations, photo mapping and semi-structured interviews. The experiments are mainly conducted using co-design tools, which have served as both data collectors and communication tools. Co-design is also explored as a tool to activate and align learning space and pedagogical practice and as such co-design attains a dual role in the research project as both research approach and research object. Finally, the analytical tools used to structure and analyse the data from the experiments are presented.

A PRACTICE-BASED DESIGN RESEARCH METHODOLOGY

As the title of this chapter indicates, the research approach in this thesis is very closely linked to the praxis of the designer. The title is borrowed from Sanders and Stappers (2014), who describe the designerly way of doing research as something different from more traditional scientific research as it involves acts of making. In design research, the designerly engagement and design practice become a significant part of the production of knowledge (Brandt & Binder, 2007; Löwgren, Larsen, & Hobye, 2013).

Traditionally, design has been associated with the arts and the technical professions. Vaughan (2017) describes how design research until recently has been under the wings of more established academic domains, which has resulted in the application of other disciplinary structures and methodologies to design research. However, this is changing. Recently, design research based on design practice has received growing attention in universities and academies, where design researchers attempt to create 'disciplinary and professionally relevant methods and modes of undertaking, disseminating and applying design research in practice' (Vaughan, 2017, p. 11). Still, as Engholm (2011) points out, research in design is a fairly young and developing field with many disciplines, mindsets and methodological practices. Therefore, according to Buchanan (2001), those involved in design research are easily drawn into other fields. Design researchers often work cross-disciplinarily and the multiple choices concerning research approaches place demands on the design researcher in regard to positioning herself in the heterogeneous research fields and to be clear about the theoretical methodological basis for her research.

Engholm (2011) maps the various branches of the research field by dividing them into three main categories: When design takes place/the process, Design in the marketplace/distribution and Design and meaning/the design object. My research project is positioned within the first category, which deals with the creation of design, the design process and design methods (Engholm, 2011). The other two categories are concerned with conditions, methods and frameworks for design management and the distribution and marketing of design (category 2) as well as the study of existing design

objects and their contexts and aspects concerning design and meaning (category 3) and are therefore not relevant to this project.

Design research through practice

The situated nature of practice-based enquiry ensures that research undertaken will produce knowledge that both deepens understanding and provides tangible applications for practice. (Laurene Vaughan, 2017, p. 10)

Traditionally, research, design and practice have been treated as separate fields, leaving research to academics and scientist, practice to practitioners and design to designers, according to Laurene Vaughan (2017). In recent years, this has changed with practitioners and designers taking on the role of researchers in their own fields, combining research with design and practice. The following section is based on Vaughan, but even relates to Christopher Frayling (1993), who originally introduced the practice-based research approach. His concept, 'research through design', has subsequently developed in several directions, including constructive design research and co-design, which I will elaborate on in the following sections of this chapter.

Referring to Peter Jarvis (1999), Vaughan explains how theory used to be considered superior to practice, which meant that research concerning the field of design and practice was conducted by non-practical experts outside the field. However, as Jarvis (1999) emphasises, 'expertise acquired outside a field is not necessarily superior to, or even relevant to, the expertise of the practitioner inside the field' (here quoted after Vaughan, 2017, p. 10).

Building on this type of insight, research through practice has become an established research approach in design research. The particular feature of this type of research is that knowledge is created in action through situated practice, drawing on the skills and expertise of the practitioner. As Vaughan's quote in the beginning of the section states, research done through practice produces knowledge that both deepens the understanding and provides tangible applications for practice. Subsequently, Vaughan argues in favour of a new title for researchers in design, which she calls 'Designer-practitioner-researcher' (p. 10). The title can be read both right to left and

left to right, she explains, but the important thing is that practice lies in the middle between designer and researcher. The reason for this is, according to Vaughan, that new and interesting knowledge can happen in the range between design, practice and research, because 'the practitioner-researcher has the skills and expertise in the actions of the field to be able to undertake situated research within it' (p. 10).

Overall, Engholm (2011) and Vaughan (2017) frame a development in design research that has taken design research from being dependent on other disciplinary traditions to becoming an independent discipline with its own research methods. In particular, research through design and design practice separate the field of design research from other research fields.

My research project is positioned within this discipline of research through design and design practice. According to Vaughan (2017), design research happens in-between design, practice and research, which is also the case in this project: Through a combination of theory and design practice, I attempt to create knowledge applicable in both practice and research.

The starting point for this PhD project has been practice as the empirical research has been conducted through practice together with Rune Fjord Studio in two schools. Vaughan (2017) explains this as 'the site of the research is the site of the practice' (p. 12). My experience with design projects under the auspices of Rune Fjord Studio has provided me with a very broad insight into design processes and the methods and strategies of a designer and the work within a design company. The experiments of this research project are developed and performed in close collaboration with the designers and architects in Rune Fjord Studio. Although I am not a trained designer, my work throughout the process has included the tasks of a designer, a practitioner and a researcher. In the first part of the research project, experiment #1, I took on the role of both designer and practitioner in the first phases of the design process, planning and facilitating workshops with the stakeholders, observing and collecting basic information as ground work for the designing of the space, participating in idea development etc. In experiment #2, I made the arrangements with the participating school, communicated with the teachers and developed the design and activities of the co-design process. I also took the lead in the facilitation of the workshops. In

experiment #3, I participated in the development of the co-creation cabinets central to the experiment.

Whilst conducting the experiments, I combined practice with research by reflecting both in and on the actions, thereby doing what social scientist Donald Schön (1983) calls 'reflections-in-action' and 'reflections-on-action'. His concept of the reflective practitioner is often referred to when discussing research methods in practice-based design research, as it explains how reflections take place during the actions of the practitioner. In his seminal work, *The Reflective Practitioner* (1983), Schön examines how professional practitioners face and solve problems. According to Schön, the best professionals know more than they can put into words as they learn to improvise based on their accumulated knowledge in practice. He describes the professional practitioner as a specialist who encounters the same type of situations again and again, thereby experiencing many variations of a small number of cases. The practitioner thereby develops a repertoire of expectations, images, and techniques, that makes him capable of practicing and becoming specialised.

Schön operates with three concepts of action when trying to describe how designers (and other professional practitioners) practice: 'knowing-in-action', 'reflection-on-action' and 'reflection-in-action'.

'Knowing-in-action' is the kind of tacit knowledge that lies implicit in our patterns of action and our feel for the things with which we are dealing. This type of knowledge underlies the everyday actions for all humans and even so for the workaday life of the professional practitioner whose accumulated expertise enables him to react intuitively and spontaneously in practice.

'Reflection-on-action' happens after the action has taken place as the practitioner analyses, reviews and evaluates the situation and actions.

The last concept, 'reflection-in-action', is most interesting in relation to practice-based design research, because doing and thinking are complementary. The reflective practitioner reflects during the process of doing, thereby being able to evolve the way of doing it simultaneously. Schön explains that 'Doing extends thinking in the tests, moves, and probes of experimental action, and reflection feeds on doing and its results. Each feeds the other, and each sets boundaries for the other' (p. 280). This often

takes place in an iterative process, where the practitioner reappreciates, reinvents and redraws the action. A similar process takes place in practice-based design research, when the researcher experiments and explores through practice, as explained by Vaughan (2017).

My educational background (MA in Art History and Aesthetics and Culture) has given me an analytical, cultural theoretical approach to research, whereas my years of working at Rune Fjord Studio have provided me with a practical approach. During the course of this PhD project, I have acquired a lot of knowledge concerning design theory, design methods and design praxis, This, I would argue, creates a connection to the designer in Vaughan's 'designer-practitioner-researcher'. Simultaneously, I have been educated as a researcher throughout the PhD process, which creates the other connection towards the researcher. For this reason, my PhD project can be considered as ranging from the middle of Vaughan's concept, the practitioner, towards both the right and the left instead of evolving from one side to the other. The combination of designer-practitioner-researcher has made it relevant for me to choose a practice-based design research approach and the methodologies and methods presented in the remainder of this chapter.

Research through design and practice

The term, 'research through design' (abbreviated RtD), was initiated by Christopher Frayling in 1993 and is today a collective name for a broad field of contributions in design research. The common denominator for these is that they are anchored in and emanate from practice-based design research. As stated by Bang, Krogh, Ludvigsen, & Markussen (2012), literature dealing with different aspects of RtD report on a wealth of methods, techniques and experiments, resulting in an increased diversity in the type of knowledge produced.

RtD covers a research approach where the design process in itself becomes a way to acquire new knowledge. The concept (originally called Research through Art and Design) was coined as a proposal to differentiate between different types of research in design and art, the other two being 'Research into' and 'Research for' Art and Design (Frayling, 1993, p. 5). In Frayling's terminology, 'research into design' refers to research

where design is being studied from the outside, e.g. from a historical, theoretical or aesthetical point of view. 'Research for design' considers design as an object and aims at improving design practice by developing methods and approaches for use in design development. Frayling's third category, RtD, refers to design praxis, where research is practised whilst developing new designs or exploring materials, including experiments and proposals as well as simultaneous research-related reflections. This category is divided into sub-areas by Frayling as either 'material research', 'development work' or 'action research', the latter being most relevant to this project. Frayling explains action research as research where 'the action is calculated to generate and validate new knowledge or understanding' (p. 4). In action research reflections are made during the design process and the results of the research are communicated through different tools such as diaries and reports, which is what separates it from merely gathering reference materials (Frayling, 1993).

According to Brandt & Binder (2007), this discussion on research on, in and through design has led to attempts at positioning research more clearly in relation to design practice and to create a venue for design research through designerly practice.

Almost simultaneously with Frayling, Archer (1995) proposed a similar terminology to explain research dealing with practice. His theory likewise distinguishes between three types of research, research 'about', 'through' and 'for the purposes of' practice (p. 11), which are notably similar to Frayling's concepts. Archer especially finds the concept of research through practice interesting because the research activity is explored through the medium of the practitioner activity. He calls this kind of research activity for action research, which he explains as a 'systematic investigation through practical action calculated to devise or test new information, ideas, forms or procedures and to produce communicable knowledge' (p. 6). According to Archer, this type of research is often conducted by 'practitioners of one or other of the useful arts', such as medicine, teaching, business or disciplines embraced by design education (p. 7). He explains that all the normal rules of research practice apply to action research, e.g. that it must be calculated to produce new knowledge or test or refute existing knowledge; data collection, enquiry and analysis must be transparent and systematically conducted and the body of work must be published and exposed to critical examination by

others. However, action research differs from other categories of research activity in one way: The researcher explicitly acts in and on the real world which makes it impossible to conduct the investigation free from personal interference, judgements and valuation by the researcher. For this reason, it is important for the researcher to clearly define the nature of the intervention as well as the theoretical, ideological and ethical position of the investigator when making the intervention, observations and judgements. Action research can hardly ever by objective and is almost always situation-specific, which means that 'its findings only reliably apply to the place, time, persons and circumstances in which that action took place' (p. 12). Arguably, this is the case for much research done within the humanities since the interpretive turn from rationalism to relativism, recognising that our knowledge of the world is always conditioned by our experiences and our culture. It is not possible to be objective in a post-structuralist constructivist approach because there are no 'hard facts' cementing the research findings.

Despite the impossibility of reproducing the findings of an action research project, Archer still claims that the findings from these types of research projects are extremely valuable as they produce insight that might otherwise never be obtained.

The similarities between the research terminologies by Frayling and Archer are striking, but Frayling's concept of RtD is the most commonly used when it comes to practice-based design research. Therefore, I will mainly refer to RtD in this thesis.

RtD is described by Zimmerman, Stolterman, and Forlizzi (2010) as the 'process of iteratively designing artifacts *[sic]* as a creative way of investigating what a potential future might be' (p. 313). In RtD, the research inquiry is investigated through the practitioner's methods and practise is acknowledged as a means of gaining new knowledge. In my project, this meant both the exploration of design tools and co-design workshops in the design and activation process as well as the development of concrete spatial environments while working in an iterative dialogue with a physical material and the users that reflected back on the research. RtD as a methodology has allowed me to generate new knowledge through both design and co-design processes that simultaneously developed, tested and improved spatial designs and methods for designing learning space designs. The research reflections were generated in and on

action (Schön, 1983) in real-life projects, where both design processes and concrete design proposals were explored and evaluated. The research experiments took place through direct designerly action, which was conducted under almost normal professional conditions. The research was thus not only conceptual, but it empirically explored the relationship between space and practice though practice. This is what Frayling and Archer call action research—research which explicitly takes action in and on the real world.

When doing action research, Archer emphasises the importance of a transparent and systematic research process where data, enquiry and analysis are published and exposed to critical examination by others. In this project, data was collected using various qualitative research methods such as participant observation (Szulevicz, 2015), semi-structured interviews (Tanggaard & Brinkmann, 2015b) and photo documentation (Holm, 2014). During the experiments, I kept logbooks and thoroughly documented the actions taking place in order to be able to reflect upon and analyse the participatory processes and findings. The findings were continuously evaluated and shared with and exposed to critical examination by peers in network groups, conference papers and in an academic book chapter. The data collection methods and analysis will be elaborated on later in this chapter.

Action research

In the previous sections, I argued that my research project was performed as action research according to the definitions by Frayling and Archer. As a research practice, action research was developed in human and social studies in the United States and England after the Second World War and is often referred back to the German-American psychologist, Kurt Lewin (1890-1947). The research practice was developed as a counterbalance to contemporary research, which Lewin regarded as incapable of producing knowledge with a relevance when it comes to solving demanding social tensions and oppositions in the American society and creating a democratic culture (Nielsen & Nielsen, 2010). In action research, the researcher works in close collaboration with both practitioners within a field and the affected citizens to create solutions to social problems through analysis and experiments in the local context.

This approach was believed by Lewin to procure qualitative knowledge, which was different than traditional research (Nielsen & Nielsen, 2010).

According to Reason and Bradbury (2008), action research is 'not so much a methodology as an orientation to inquiry that seeks to create participative communities of inquiry in which qualities of engagement, curiosity and question posing are brought to bear on significant practical issues' (p. 1). Action research projects thus evolve and address questions and issues of interest and relevance to those who participate in the projects as co-researchers. Reason and Bradbury further emphasise that the starting point for action research is everyday experience and the aim is to develop living knowledge, which is why the process of inquiry can be just as important as the actual outcomes. Action research is participatory research that seeks to bring together action and reflection, theory and practice, with the aim to create new forms of understanding and create practical solutions to issues of pressing concern to people. Therefore, the scope and impact of such projects can both involve creating positive change on a small scale or affect the life of millions of people (Reason & Bradbury, 2008).

Argyris and Schön (1991) describe action research as research bound within a practice context, which it both tries to research and affect:

> Action research takes its cues – its questions, puzzles, and problems – from the perceptions of practitioners within particular, local practice contexts. It bounds episodes of research according to the boundaries of the local context. It builds descriptions and theories within the practice context itself, and tests them there through intervention experiments – that is, through experiments that bear the double burden of testing hy¬potheses and effecting some (putatively) desirable change in the situation. (Argyris & Schön, 1991, p. 86)

In my research project, 'questions, puzzles and problems' concerning the interplay between space and practice also arose from the close collaboration with practitioners (mainly in Rune Fjord Studio) and participants in the design experiments. The overall focus has been on collaborative processes in which design tools and design processes were explored and evaluated through direct designerly action in participatory projects,

carried out in local contexts and under (almost) normal professional conditions. The research was conducted in the practice context of the design agency, Rune Fjord Studio and in two schools, A and B, with both designers and stakeholders (mainly teachers and students) involved as sparring partners, participants and co-researchers. The experiments took place in the local context of the participants, the school space, and had a dual purpose of both researching assumptions and potentially effecting change, as emphasised by Argyris and Schön (1991).

The project evolved following the interaction with the local contexts, where theories and descriptions regarding the space-practice relationship, co-design tools and participatory design processes were developed within the practice context, as defined by Argyris and Schön (1991). The findings from the first experiment—or puzzles and problems—led to the development of experiment #2 and #3. In all three experiments, new ways of connecting space and practice were explored, often very directly, together with the participants (mostly teachers and students) in their actual learning environment. The project created practical outcomes, actual spatial designs, and also attempted to develop new knowledge about the relationship between space and practice that will potentially contribute to a further understanding and development of learning space design. In this sense, the research has been conducted as action research as defined by both Reason and Bradbury (2008) and Argyris and Schön (1991).

Challenges and advantages of a practice-based design research approach

In the previous sections of this chapter, I defined my research project as RtD (Frayling, 1993) and action research (Archer, 1995; Argyris & Schön, 1991), based on my design research being conducted through practice and in action. The practice-based design research approach has its challenges as well as its advantages, which I will reflect on in the following.

According to Argyris and Schön (1991), the challenge for an action researcher is to 'define and meet standards of appropriate rigor without sacrificing relevance' (p. 85). This is backed up by Archer (1995), who points out that action research 'can hardly

ever be objective, in the strict sense of the word' (p. 11). The reason for this is that the research is conducted through action in and on the real world with all its complexity and the findings are, according to Archer, almost always 'situation-specific' (p. 11). This means that the findings apply especially to the particular time, place, persons and circumstances in which the action took place and are thus rarely generalizable.

At the same time, Archer argues, the findings from action research are extremely valuable due to the type of insights produced. These insights can help advance practice and provide material for other more generalizable studies. This corresponds with Reason and Bradbury (2008), who declare that:

> *A primary purpose of action research is to produce practical knowledge that is useful to people in the everyday conduct of their lives. A wider purpose of action research is to contribute through this practical knowledge to the increased well-being – economic, political, psychological, spiritual – of human persons and communities, and to a more equitable and sustainable relationship with the wider ecology of the planet of which we are an intrinsic part. (Reason & Bradbury, 2008, p. 4)*

Binder and Redström (2006) point out another challenge, relevant for both action research and design research, which relates to the role of the researcher in interventionist action with the participants. Since the researcher is deeply involved in the intervention, for instance a process of change, while at the same time monitoring and evaluating the effects, he or she becomes dependent on the success of the project. This means that the researcher might become unable to challenge assumptions and results.

The challenges mentioned here also apply to this research project, as it was conducted in a very specific situative context in the design practice of Rune Fjord Studio and in the everyday practice at School A and School B. My research was conducted in close collaboration with both practitioners and stakeholders (mainly the users of the learning spaces) in all three experiments under (almost) normal professional conditions. The findings therefore especially apply to the specific time, place, persons and circumstances of the three design experiments, which arguably limits the scope of

the research. At the same time, this can be acclaimed to be the value of the project as it provides unique insights into actual design processes of learning spaces and explores actual design workshops with participants, thereby providing knowledge which could not be attained through a merely theoretical or quantitative approach. Despite being 'situation-specific', as Archer (1995) calls it, I would still argue that the findings of the projects potentially apply to a broader context based on the nature of the challenges and needs experienced in experiment #1-3. However, the possibility of applying similar design processes and tools in other contexts needs more research.

Another challenge in the project is my personal involvement in the actions and my dual role as a researcher connected to both KADK and Rune Fjord Studio, as explained earlier. The relationship with a commercial company while conducting academic research could have left me biased and wanting the experiments to succeed in order to make both me and the company 'look good'. With reference to experiment #1 in particular, I argue that this has not been the case. The design process and the finished design in experiment #1 did not turn out as intended and as such is not a successful design story. On the contrary, the alignment of space and practice failed and the relationship between space and practice was restrained and problematic. However, this 'failure' became a successful base for the development of experiment #2 and #3, which furthered the progress of the research project. As far as my personal involvement is concerned, I have tried to create a distance by consulting literature and other research results on a regular basis.

RESEARCH DESIGN, METHODS AND TOOLS

In the second part of this chapter, the methodology of the research project will be narrowed down from a theoretical perspective to a practical approach as I present and discuss the research design and the methods of the project. In the following, I will introduce constructive design research and programmatic design research as a research approach and a way to frame and structure my design research. I will also introduce co-design as both a design approach and a research tool.

Constructive Design Research

Frayling's concept of RtD has been criticised for its lack of theory to guide practices (Godin & Zahedi, 2014; Koskinen et al., 2011) and arguably it appears more like an initial concept than a proper methodology in Frayling's working paper from 1993. In an attempt to substantiate and develop the concept of RtD further, Koskinen, Zimmerman, Binder, Redström and Wensween (2011) propose a new approach called 'constructive design research' that 'refers to design research in which construction – be it product, system, space, or media - takes center place and becomes the key means in constructing knowledge' (p. 5). They explain constructive design research as '...a science of the imaginary' (p. 42), where research happens through practice as the researchers imagine and build new realities to see if they work, e.g. prototypes, mock-ups, scenarios or detailed concepts, and subsequently describe and explain these constructions. This gives the design researcher a possibility to 'actively participate in intentionally constructing the future, in the form of disciplined imagination, instead of limiting their research to an analysis of the present and the past' (p. 5). According to Bang and Eriksen (2014), constructive design research encompasses the massive body of work within the field of RtD, where design researchers address and exemplify ways in which design examples and practice can contribute to knowledge generation in design research.

Koskinen et al. (2011) divide the research conducted within the framework of constructive design research into three categories, which they call Lab, Field and Showroom, inspired by the natural sciences, the social sciences and the art world, respectively. In their terminology, the lab researcher brings things of interest into the lab for experimental studies isolated from a context, whereas the field researcher works with designs in a context and examines the way people understand, talk about, make sense of and live with them. Many designers doing fieldwork use co-design or co-creation methods to involve stakeholders or users in the design process. Finally, the last type of researcher, the showroom researcher, treats the design construction as the final presentation of the work and its process.

Research methods in constructive design research vary from the more traditional methods like observations and interviews to usage of cameras and video to collect

data. According to Koskinen et al. (2011), a growth of 'generative' research methods that put design practice at the core of the research process took place in the 1990s and 2000s. The methods were inspired by design practice and included design tools such as collages, mood boards, storyboards, scenarios, personas, design games, prototypes and various types of role-playing as we see it in participatory design.

The design experiment is highlighted as central in RtD and constructive design research (Bang & Eriksen, 2014; Brandt & Binder, 2007; Krogh, Markussen, & Bang, 2015). Based on existing literature and their own research projects, Bang and Eriksen (2014) argue that design experiments play a core role in different stages of constructive design research as they can be used for conducting research, constructing theory and for generating knowledge. This will be discussed further in the following sections.

Summing up, constructive design research as a new methodology elaborates and evolves the concept of RtD in order to encompass a wide range of practice-based design research, where the research core is based on the construction of design and practice. In particular the design experiment is argued to be important in the process of conducting constructive design research (Bang & Eriksen, 2014). The interventionist and constructive approach applied in constructive design research requires active engagement and interaction by the researcher and as such is inspired by action research. As explained earlier, action research suggests a participatory approach to knowledge generation and brings together action and reflection, which is applicable in many research fields. This approach is subsequently transmitted and translated by constructive design research to match the particular field of design research. As such, both have grown out of the RtD-tradition.

With the presentation and discussion of RtD, action research and constructive design research, I have tried to outline and characterise the practice-based research tradition and the field in which this PhD project is positioned. The research approach and methods of my project have developed regeneratively, as the research progressed, in line with the explorative and inquiry-based approach of practice-based design research where everything unfolds as a process. It is due to this generative approach of my research that the project draws on RtD, action research as well as constructive design research.

In the following I will elaborate and discuss the constructive design research approach of this project, where design constructions, as proposed by Koskinen et al. (2011), constitute the core of the research inquiry. The practice-based research builds on three design experiments conducted in two schools between 2016 and 2018. Here, design practice has been used to build knowledge about design methods and design issues, which could potentially help to improve the relationship between learning space designs and pedagogical practices.

The research process was based on several constructions, physical as well as conceptual, that were developed as part of the experiments. My research has evolved around these constructions, where I, as a design researcher, have been given the possibility to 'actively participate in intentionally constructing the future' (Koskinen et al., 2011, p. 5). In this project, constructing the future meant constructing design processes and tools for user participation in the design and activation of new learning spaces. My empirical research emerged from the design studio Rune Fjord Studio and took place in a 'real' context in the two schools, where approaches from co-design were used to involve stakeholders and users in the design process. The constructions used to build new knowledge in this project took the form of *spatial designs* (an innovative learning environment), *furniture prototypes* and *co-design tools* that examined ways to engage the users in the design and use of physical learning environments. The design constructions thereby mainly served as tools to explore and improve the alignment of the learning space design and the pedagogical practices. The design experiments and prototype exploration took place in the field, involving the participants in the design processes whilst being in their own physical environments. The purpose was to make the participants reflect upon and discuss their learning spaces in relation to their pedagogical practices. Therefore, the experiments were not kept secluded from external influences, but interacted with, were infiltrated and became affected by the realities they were part of. This places the research project in the constructive design research category 'field', as defined by Koskinen et al. (2011).

In the following, I will explain how the research project was performed using a programmatic design research framework proposed by Binder and Redström (2006), Bang and Eriksen (2014) and Redström (2017), amongst others. The programmatic

framework builds on the previously presented practice-based research approaches and offers a tool to help frame, facilitate and structure research processes in e.g. constructive design research. This is also the way the framework is used in this research project.

Programmatic Design Research

Several researchers in practice-based design research place the design experiments at the centre of design research (Bang & Eriksen, 2014; Brandt & Binder, 2007; Krogh et al., 2015), which also applies to constructive design research. The same goes for experimental design research (Brandt & Binder, 2007) and programmatic design research (Binder & Redström, 2006), where experiments are conducted in relation to a framework: a program. In experimental as well as programmatic design research, making and experimenting are intertwined with theorizing (Redström, 2017).

I have chosen to use a programmatic design research approach in my research project as it provides a methodological means to framing and structuring the empirical research as design experiments in relation to an overall research issue, a program. Adhering to the choice of this approach, I define my empirical research as design experiments and not, for example, case studies.

The programmatic design research approach has been substantiated in several publications since 2006 by e.g. Brandt, Redström, Eriksen, and Binder (2011); Koskinen et al. (2011); Bang and Eriksen (2014) and Redström (2017). According to Redström (2017), programmatic design research proposes a research approach for practice-based design research, where the structure of the research basically consists of two elements:

- A program (consisting of a set of basic beliefs, design ideals or intentions) and;
- A set of design experiments that challenge the program.

In programmatic design research, the researcher establishes a 'worldview' (or a 'knowledge regime', as Brandt et al. (2011) calls it), which is used to frame and contextualise the research inquiry. This worldview becomes the program for the design research by acting as a frame and a foundation for the execution of a series of design experiments (Brandt et al., 2011). The program and the experiments are

interdependent and both the worldview of the program and at least one experiment must be present in order to make the programmatic structure come to life. It is a dialectic relationship, where most knowledge is gained in the relation (Brandt et al., 2011). Redström explains this as:

> Taken together, the program and its typical experiments constitute the programmatic structure's stabilizing elements. Once a strong bond has been established between them, it becomes increasingly difficult to find alternative interpretations. It does not matter so much which of them emerges first; they still depend on each other to the extent that they only fully play their parts when both of them have become present. (Redström, 2017, pp. 107-108)

This means that the program and the experiments together are the primary stabilizing elements of the programmatic structure. Moreover, the program is not necessarily established first in programmatic design research. It can also start with an experiment, which then helps evolve the final program. Still, neither becomes really important until both have been established. In the next sections, I will elaborate on the roles of the program and the experiments, followed by an explanation of my research project in a programmatic design research framing.

The role of the research program

> The program acts as a lens through which certain things will become enlarged and thus better seen, but where others will become hidden. Its validity therefore depends on the changes in practice it suggests, e.g., the potential of the design space being opened up. In other words, design programs exist in competition with each other, as they all propose certain ideas as more interesting, important or relevant than others and as they do so by proposing a certain way of doing things. (Binder & Redström, 2006)

In the quote above, Binder and Redström explain the research program as a lens that both enlarges and hides certain things. In other words, the program is the lens with which the design researcher scrutinises a specific research topic. Therefore, the

research program plays a very central role in programmatic design research as it states an attitude and a position of a research study and acts as a frame and foundation for its design experiments (Bang & Eriksen, 2014). The program always has a core idea and intention that shapes and structures the research conducted (Koskinen et al., 2011), because it depends on a certain worldview to be effective (Redström, 2017). The worldview can be defined as a basic set of beliefs and assumptions that constrains the research activities and makes the particular inquiry relevant (Brandt et al., 2011). It is a situated and hypothetical worldview that represents a position that is opposed to other programs (with their worldviews). In order to be effective, the worldview has to be kept quite simple and basic, because, as Redström points out, 'a program that allows anything to happen will not work' (2017, pp. 98-99). Its outcome will simply be too general. At the same time, the program has to be open for explorations, surprises and new insights, according to Eriksen (2012). Thus, the program will create a structured, yet open, space for experimentation that makes innovation and future development possible (Brandt et al., 2011).

The worldview of the program works as the basic conditions and restrictions for the scope of the design research. Redström (2017) explains, that the worldview is unquestionable until the program is pushed so far by the research activities that its worldview is fundamentally questioned and it has to be terminated or changed into a new program. As the design research unfolds and develops, it either substantiates or challenges the worldview of the program (Brandt et al., 2011).

Programs can be used to 'articulate provisional foundations, to state worldviews that we want to explore as if they were true so as to learn something about what kind of design they would lead to' (Redström, 2017, p. 97). Redström explains:

> ...what is important about the program from a design theory point of view is not that it precedes or governs experimentation, but that it constitutes a definition of what designing is at a level of abstraction that experiments as such do not address. (Redström, 2017, p. 102)

The program defines what designing is, based on the particular worldview that it

advocates. Contrary to this, the experiment defines what a design is (Redström, 2017). In combination, the program and the experiment address the underlying research questions, thereby providing the most important knowledge of the research project (Brandt et al., 2011). I will return to the program and the relationship between program and experiments in the following as I explain the role of the design experiments in programmatic design research further. Subsequently, based on these theoretical explanations, I will introduce the empirical research in this PhD project in a programmatic framework as design program and design experiments.

The role of the design experiments

As Bang & Eriksen (2014) explain, design experiments can play a central role in practice-based design research as they are used for both knowledge generation and theory-building. According to Brandt & Binder (2007), the design experiment is a means to exploring and challenging a program, which is why it can take various forms such as explorations with mock-ups, prototypes, scenarios, probes and artefacts. Bang & Eriksen (2014) elaborate on this concept by claiming that experiments also have different purposes and generate various knowledge. As examples, Bang and Eriksen define three types of experiments in programmatic design research. Their categories are inspired by Schön, who proposes that experiments in practice have different purposes and generate different knowledge by being either explorative, move testing or hypothesis testing (Bang & Eriksen, 2014; Schön, 1983). The first type of experiment proposed by Bang & Eriksen appears in the early stages of a research study as *initiator or driver framing the research program* and is related to Schön's explorative experiment. These kinds of experiments are driving or initiating experiments that are intertwined in framing a research program (Bang & Eriksen, 2014, p. 4.8). The second type of experiments can be used to *reflect on, drift and mature the research program*, thereby serving as vehicles for theory construction and knowledge generation. These experiments are similar to Schön's move testing experiments and can cause a program to drift and be reframed or help mature and stabilize it (p. 4.9). The last type of experiment is *finalizing the research*, being a designerly way of positioning and contextualising the research program and its research contributions. This type of experiment is similar to what Schön calls hypothesis-testing experiments (p. 4.8).

Redström (2017) likewise proposes that design experiments can take different forms and appear in different stages of the research process, i.e. as initial experiments in the early phase of the program or as typical and atypical examples during the midlife of a program (pp. 108-109). The experiments should seek the program's boundaries and breaking points in order to challenge the ideas behind the program and develop new areas and ideas, new knowledge and new programs (Redström, 2017). Experimentation, though, is not just an attempt at materializing, exploring or challenging a given design research program, but might just as well start before the actual framing of the program has been articulated. In this way, Redström explains, experimentation becomes part of the process through which the program is formulated.

The different types of experiments proposed in this section will be used to define the design experiments and their role in my research project later in this chapter.

The relationship between program and experiments

Redström (2017) claims that the design program and the design experiments together have the potential to create something that neither can do on its own. This corresponds well with the explanation by Brandt et al. (2011) that program and experiments should be considered as a whole when addressing the production of knowledge of the research.

The relationship between program and experiment is complex and dynamic (Redström, 2017) as each component depends on the other. The program suggests a certain approach to the design of something (in this project 'something' is learning spaces), which the experiments then explore and express in order to answer the research questions. Thus, it is the combination of program and experiment that addresses the underlying research questions (Brandt et al., 2011).

In addition, the program and its experiments are surrounded by and positioned in a wider context that influences the program and to which the program 'talks back', as explained by Bang and Eriksen (2014). To capture this dialectic relationship, Brandt and Binder (2007) propose a diagram visualising how the program, experiments and research question interrelate and how the relationship is driven by the designerly experiments (Figure 8). The program is visualised in the middle as an intermediary between research question and empirical exploration. The question is placed outside

the program due to the fact that the insights obtained through design research often have potential outside the programmatic context. Brandt and Binder (2007) explain that the research question guides the inquiry by exploring e.g. a concept, while the program frames and contextualises the experiments. They exemplify this by proposing that the research question could explore a concept like performativity, while the program could propose to stimulate creativity through the employment of particular tools and methods.
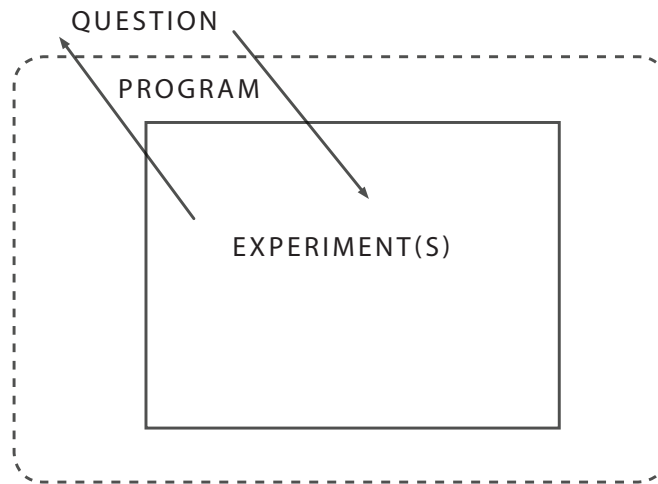
Figure 8. Diagram by Brandt & Binder, showing the dialectic relationship between question (context), program and experiments (adapted from Brandt & Binder, 2007).

The diagram also shows how a design research study can be initiated either from the outside by identifying and positioning larger questions (the wider context) or from the inside through the experiments (Bang & Eriksen, 2014).

The diagram has been criticized by Bang and Eriksen (2014) for showing the units that constitute a research program without addressing the more dynamic processes of researching with a research program. Addressing this issue, Bang has developed a modified diagram (Figure 9), where she tries to capture the dynamic interplay between research questions and design experiments in relation to the research program framed within the context of the overall challenges. She also visualizes how the relationship between program, experiment and research questions ultimately attempt to create

answers that 'talk back' to the overall challenges. In Bang's diagram, the question by Brandt and Binder has been divided into two, as Bang distinguishes between research questions and challenges. Her explanation is that there is a difference between the research question which 'can refer to overall challenges that initiate a research project' and 'specific research questions that guide the particular enquiry', because they have different roles in the research project (Bang, 2011, p. 49).
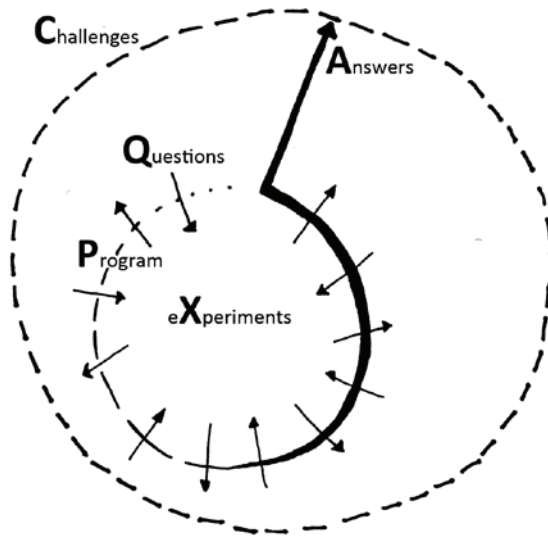
Figure 9. Diagram by Bang, showing the dynamic process of researching with a research project. Reprinted from Bang & Eriksen, 2014, p. 4.5.

Brandt and Binder (2007) as well as Bang (2011; 2014) attempt to visualize the interrelationship between the different parts of programmatic design research in their models. However, I find the model by Bang more fitting and illustrative in relation to my project. Therefore, her model has worked as a tool for me to structure and illustrate my research project, which will be elaborated on in the following section. Using a programmatic design research approach has provided me with the possibility to explore my research inquiry through a dynamic interaction between my program, design experiments, research questions and the overall challenge of designing learning

spaces which originally initiated the research project. It is in the interaction between these elements, in particular the program and the experiments, that new knowledge concerning the relationship between space and practice has been produced.

From challenge to design experiment in this project

Inspired by Bang (2011), I have used the different terms in the diagram in Figure 9 to create an overview of the structure and elements of my research project in a programmatic perspective. The elements have been divided into five parts: Challenge (C), research questions (Q), program (P), experiments (X) and answers (A), as proposed by Bang. This has helped me understand the structure and relationships of my research project as presented in Figure 10.

As explained in the first chapter of this thesis, the wider context of this research project is formed both by many years of practice in a design studio dealing with the design of new learning environments and by my repeated experience of mismatches between design and pedagogical intentions and actual practice in new or redesigned learning spaces. This has led to the initiation of this research project and to the formulation of a problematic issue that represents the overall challenges (C) of this research project, namely how to design physical learning environments that match pedagogical practices. This 'question' defines the overall challenges that have led me to embark on this research quest and should not be confused with the research questions that this particular research project attempts to answer.

The program (P) was formulated as an answer to the overall challenges (C) and proposes a worldview on the design of learning spaces, where the focus is on unlocking learning spaces through participatory processes. The research questions (Q) and the design experiments (X) emerged and developed as the research process progressed. The research questions have continually been explored, revised and sharpened throughout the research project following the interaction between program, experiments and context. Similar processes have been reported by Bang and Eriksen (2014).

The experiments (X) came into being progressively. The first experiment was initiated as part of an actual assignment in Rune Fjord Studio, whereas experiment #2 and #3 developed from the findings in experiment #1. Finally, the outcome of the

research project which provides answers (A) to the overall challenges was defined during the final process of writing this thesis.

In the following I will elaborate on the two main elements which constitute my programmatic design research structure—the program and the experiments.
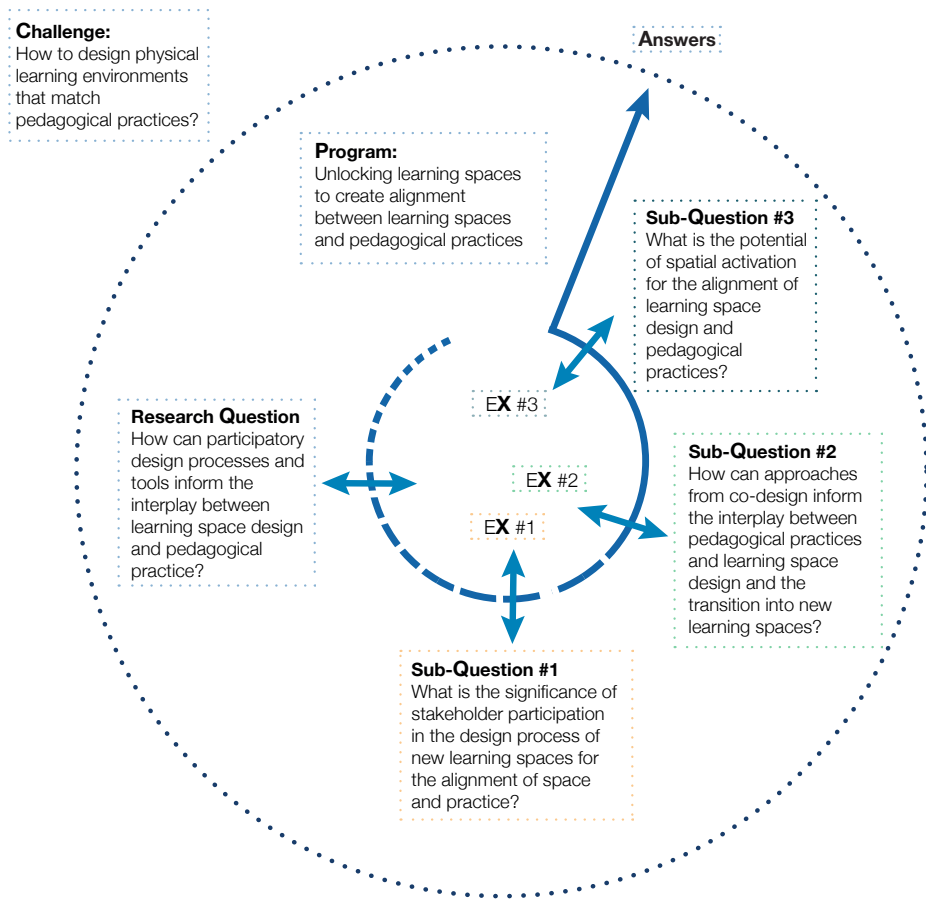
Figure 10. The programmatic approach of my research project set up according to the diagrammatic structure proposed by Bang, 2011.

The program: Unlocking learning spaces

The reflections connected to the overall challenge concerning the design of learning spaces helped form the program of this research project concerned with 'how to "unlock" learning spaces to create alignment between learning spaces and pedagogical practices.' The program has framed and contextualised the three design experiments by proposing a participatory and constructive design research approach to the design of learning spaces. In this, it suggests that stakeholder participation in the design process of learning spaces can serve as a means to inform the relationship between learning space and pedagogical practice and that extended involvement of the users is required in the process of designing learning spaces before, during and even after the design and implementation of the spatial design. This approach is subsequently explored in the design experiments in an attempt to answer the research questions.

Initially, this research project was intended to focus on creative learning spaces by examining the interplay between learning space design and creative learning. However, this focus shifted during the first year of the project due to several factors, including the literature studies, the process and outcome of experiment #1 and discussions with fellow peers. The problematics of creating alignment between learning space design and pedagogical practices became very visible in the findings of experiment #1, where the spatial design did not alter practice. This was partly ascribed to the lack of user involvement in the design process, which contributed to the change in focus from creative learning spaces to participatory design processes. Part of this was due to me realising that a creative learning space design, no matter the quality and the layout, would lose its intended functions if the users—either from lack of knowledge or lack of will—did not use the spatial possibilities to foster creative learning processes. Hence, the process of designing became more interesting for me to research than the physical layout.

During the research process, I have reconsidered the program continuously as I have learned from my experiments, literature studies, conferences and meetings with fellow peers. Design experiences from the past during my work at Rune Fjord Studio have also helped form the program as stated above. These past experiences (or experiments) are not part of this thesis as this would extend the scope of the

project profoundly. However, I would like to mention a project that I find especially relevant and explanative for the articulation of the overall challenges and the research program, because, according to Redström (2017), a design experiment might just as well precede the formulation of a program. In 2016, Rune Fjord Studio designed an activity-based workspace for teachers in school A (the school featured in experiment #1). The new design proposal replaced a previous design proposal where the teachers were to obtain a personal desk each. At first, the teachers were extremely sceptical and reluctant to the idea of an activity-based work space, but an extensive focus on teacher participation in the design process helped transform their scepticism into approval, and the final design of the space became very well-liked amongst the teaching staff. This experience (which could also be called a design experiment) has contributed to the formulation of the program as it demonstrates how the interplay between space and practice depends on the involvement of the users during the design process.

Another influential factor on the program in my research project is the connection with Rune Fjord Studio. Since the project is partly funded by Rune Fjord Studio and has been performed under the auspices of the studio, the program is partly formed and framed by this connection. This means for instance that the design experiments, in particular experiment #1, were initiated as part of a genuine design project in the design studio, which has both framed and set boundaries for the investigations.

The design experiments in this research project

As explained earlier, the core of this research project consists of three design experiments. These experiments were conducted from the fall of 2016 until the summer of 2018 and were partly intertwined. Experiments #1 and #2 were conducted in a linear process, where the second experiment succeeded the first, whereas experiment#3 took place simultaneously with #1 and #2 as part of their research process. Still, experiment #3 is treated as an independent experiment. The nature and process of the experiments will be elaborated later.

During the research project, the experiments were experienced to continuously 'talk back' to the program, which they were experienced to both challenge and substantiate. In order to create an overview of the timeframe, type and approach, I

have listed the experiments in Figure 11. The type of experiment is defined according to the definitions by Bang & Eriksen (2014) and Schön (1983), described earlier in this chapter.

Design Experiment	Year	Type
EX1: The process of designing an innovative learning space	2016-2017	Spatial design / the design process Initiator, driver/explorative
EX2: Co-design as a tool in participatory activation of learning spaces	2018	Co-design tools / the design tools Reflect on, drift and mature/move testing
EX3: The co-creation cabinets	2017-2018	Prototype / the design Reflect on, drift and mature/move testing

Figure 11. Diagram of the design experiments

The overall structure of the experiments can be categorised as expansive according to the definitions by Markussen, Krogh & Bang (2015) as illustrated in Figure 12. In line with the generative and explorative approach of constructive design research, my research project developed and grew in an iterative process based on and together with the actions and constructions of the design experiments.
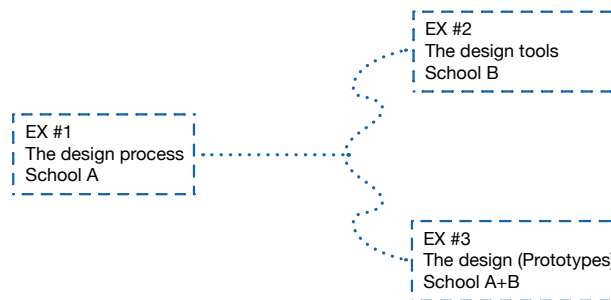
Figure 12. The expansive typology of experimentation in this project is inspired by Krogh et al. (2015) and Markussen, Krogh, and Bang (2015)

In the method of expansive design experimentation knowledge is obtained on the basis of insights gained in the relationship between design experiments and a conceptual framework but with various evaluation criteria. This means that the experiments are conducted without a strict successive or linear order. Instead they can be characterised

as 'broadening' and 'extending' knowledge as explained by Krogh et al. (2015). The expansive method serves to reveal and identify qualities of an area as yet uncovered and attempts to broaden the perspective and concerns of the designer's praxis.

Experiment #1 took place in School A and was mainly focusing on the entire design process of a new innovative learning environment and the attempt to involve different stakeholders in the process. The findings and insights from this experiment helped define the program and lead to the development of experiment #2 and #3, thereby being what Bang & Eriksen (2014) call an initiator or driver framing the research program and what Schön (1983) calls an explorative experiment.

Experiment #2 took place in School B and consisted of a series of co-design workshops that examined the potential of co-design as a tool in participatory activation of learning spaces. Co-design is commonly used as a tool in pre-design and during the process of designing, but experiment #2 examined its potential in an activation process in a post-design phase.

Experiment #3 took place simultaneously with experiment #1 and #2 and consisted of two sub-experiments or parts that were subsequently compared to each other. Part 1 took place simultaneously with experiment #1 in the same research processes at School A. Two prototypes of furniture, named co-creation cabinets, were developed for experiment #1 as part of the interior design. The prototypes were intended to support a more flexible use of the learning space and foster creative learning processes as part of the pedagogical practices at the school. The prototypes were reused in a slightly modified version in School B in experiment #2, where they functioned as both tools and study objects. The use of the prototypes was compared in an attempt to feed into the research program concerning the interplay between the physical learning space design and pedagogical practices. Experiment #2 and #3 can be categorised as experiments that reflect on, drift and mature the research program (Bang & Eriksen, 2014) but also move testing (Schön, 1983). A more in-depth explanation and analysis of the individual experiments will be presented in chapter 5.

Both Brandt et al. (2011) and Redström (2017) specify how the interesting knowledge in programmatic design research is created in the relationship between program and experiments. This means that it is not the program or the individual experiment

alone, which accounts for the important results. Rather, it happens in the dynamic interaction and counteraction between the programmatic parts.

I found this to be true in my research project as well. I have experienced the different experiments with participatory design processes and design tools in schools A and B to enlighten and challenge the framing program in an attempt to answer the research questions. Alone, the experiments might appear somewhat fragmented, but in the interaction with the program they tell a story about the design process of new learning spaces. From this perspective, the programmatic framework has provided a framework and a foundation for the experiments, thereby raising the research to a level above the individual experiments.

Co-design: A participatory approach

Co-design plays a central role in this research project, where it is used as a research approach and a tool but also examined as a study object. The choice of co-design grew out of the reflections connected to the overall challenge and the program framing the research project and became a solution to my need for a designerly research tool that could be used in a practice-based research process with many stakeholders. The problem area of this research project is rather complex as it deals with people's experiences, attitudes and competencies in relation to the design and use of learning spaces. For this reason, many different actors have been involved in the experiments. In order to be able to communicate with the various actors as well as gather data and information that would feed back into the research project, I needed concrete methods and tools that could help engage people and activate known as well as unknown knowledge and experiences. I found the tools for this in co-design. During the course of the project, co-design even became an object of study. In experiment #2, co-design was examined as a means to creating reflections on the space-practice relationship and, through this, developing spatial awareness and activating the learning space in relation to pedagogical practices.

Co-design derives from a participatory design tradition, the origin of which is often linked to research into systems design and automation in the 1980s and 1990s in America and Scandinavia. It has its roots in the participatory design techniques

developed in Scandinavia in the 1970s, where users or non-designers (a term often used in co-design, which refers to people who are not trained in design) were given more influence and room for initiative to provide expertise and participate in the informing, ideating, and conceptualising activities in the early design phases (Sanders & Stappers, 2008). Today, it spans across a broad spectrum of domains and makes use of a wide repertoire of tools and techniques (Brandt et al., 2012; Sanders, Brandt, & Binder, 2010).

The notion of the participatory mindset was introduced by the American anthropologist and design researcher Elizabeth Sanders, who distinguishes between the expert mindset and the participatory mindset, where the former focuses on designing for people and the latter on designing with people (Bang, 2011). She advocates for a greater understanding of what people say, do and make in order to access experiences and establish empathy for the users. Basically, the concept of participatory design refers to design activities where designers and non-designers work together to develop new designs. It takes place in many communities, companies, businesses and organisations who engage the people they serve in the front end of the design process. Participatory design differs from other discussions about possible futures by actively and simultaneously exploring what to achieve and how to achieve it together with a group of actors (Brandt et al., 2012).

In co-design, the users become central to the design process as 'experts' of their own experiences. The users are involved in the design process, where they play an active role in knowledge development, idea generation as well as concept development. This means, that they both contribute to the formulation and to the solution of the problem (Sanders & Stappers, 2008). This also shifts the role of the designer from being supercilious and deciding to becoming an enabler of collective actor networking, much in line with the mindset of ANT (Storni, 2015). This stands in contrast to a more design driven approach where the designer is the expert who designs the complete solution based on what she thinks the users need. In co-design, the design process becomes a democratic and collaborative arena with consistent user participation in the development of the design as the designer and user engage in 'designing things together' (Storni, 2015, p. 173).

Approaches in co-designing

Co-design has grown in importance and use during the past few years. According to Brandt et al. (2012), this has resulted in a wide range of tools and techniques that the designer can choose from when involving stakeholders in the design process. However, the terminology used to describe the application of participatory design is often inconsistent, as it comes from many different sources. Therefore, Sanders et al. (2010) propose a definition of key participatory design concepts, which I will use in this thesis:

- Tools = the material components that are used in participatory design activities. In this thesis tool is even used in the sense of instrument.
- Toolkit = a collection of tools that are used in combination to serve a specific purpose.
- Technique = Technique describes how the tools and toolkits are put into action.
- Method = a method is a combination of tools, toolkits, techniques and/or games that are strategically put together to address defined goals within the research plan.
- Approach = the approach describes the overall mindset with which the research plan is to be conducted.

The number of possible tools, techniques and applications are almost limitless, and the designer has to make a deliberate choice of tools and techniques in relation to the specific type of situation and group of stakeholders each time. Co-designing does not always happen naturally but needs staging, as Mette Agger Eriksen (2012) points out. According to Sanders and Stappers (2008), the users are in need of appropriate tools in order to be able to express themselves creatively in co-design processes. It is the designer's role to provide these tools and help the non-designers engage in the process, create, share insights, and envision their own ideas in collaboration. Sanders explains:

> *We put a large number of components together into 'toolkits'. People select from the components in order to create 'artifacts' that express their thoughts, feelings and/or ideas. The resulting artifacts may be in the form of collages, maps, stories, plans, and/*

or memories. The stuff that dreams are made of is often difficult to express in words
but may be imaginable as pictures in your head. (Sanders, 2000, p. 4)

Co-design processes and purposes differ greatly, which explains the large amount of and difference in tools, techniques and methods. The participatory process often aims to produce a visual outcome that can form the starting point for the design process, but this physical outcome varies considerably as well, as Sanders states in the quote above. A common denominator is that the toolkits and techniques help the users transform thoughts, ideas and 'dreams' (as Sanders put it) into something visible and communicable.

In order to organise the wide range of tools, techniques and methods, Brandt et al. (2012) have proposed a framework consisting of three different 'toolboxes' in co-designing that differentiates the types of activities: telling, making and enacting. These activities are used in iterative cycles in practices of participation as shown in Figure 13 and are often intertwined and take place simultaneously. The participants can enter the cycle at any point and move in either direction between the activities, which the arrows visualise.
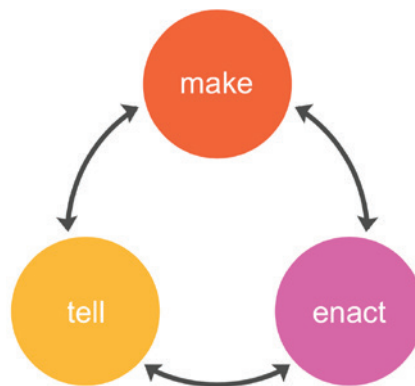
Figure 13. The interaction between making, telling and enacting in co-designing.
Source: Brandt, Binder and Sanders, 2012

Telling (stories)

The aim of the telling activities is to make participants talk about existing practices and future visions to inform the following design process. Telling activities use

different artefacts, visual materials (e.g. pictures and cards for organising ideas) and techniques (e.g. brainstorming, fictional narratives and scenario building) to assist the participants in talking about experiences, needs and dreams in a simplified way (Brandt et al., 2012). This helps the participants in discussing problems and opportunities and provides a context that keeps the discussion grounded in everyday experiences. An example, mentioned by Brandt et al. (2012), is the future workshop, where the participants move from critique of their present-day situation to a visionary perspective and finally, a plan for action.

Making (things)

A key ingredient in designerly ways of doing research, according to Sanders and Stappers (2014), is the creative act of making by both designers and co-designers. Making involves designers and non-designers in the production of tangible 'things' that are used to describe future objects, concerns or opportunities as well as views of future experiences and ways of living. Using their hands, the participants attempt to externalise and embody thoughts and ideas in the form of physical artefacts in a participatory design process (Brandt et al., 2012). Eriksen (2012) emphasises that 'reifying, making and materializing with materials is widely recognized as important in co-designing' (p. 139).

Contrary to the traditional design process, where the act of making is usually performed by the designers after the scope of the design project has been identified, making in co-design processes has become an activity that both designers and co-designers can take part in during all phases of the design process. Sanders and Stappers (2014) suggest that different approaches to making are relevant in different stages of the design process: In the earliest phase of a design process, making activities are used to make sense of the future. Later on, different types of visualisations (e.g. scenarios and storyboards) make it possible 'to experience, test, transform, develop and complete' early ideas (p. 6). Finally, in the later phases, making often takes the form of a prototype to test whether a concept should be pursued further. The techniques of making include maps, collages, mock-ups and models that are made by the participating non-designers.

Enacting (possible futures)

The third toolbox proposed by Brandt et al. (2012) is inspired by theatrical techniques and engages people to 'imagine and act out possible futures by trying things out (by use of their bodies) in settings that either resemble or are where future activities are likely to take place' (p. 164). The enacting activities use the human body to illustrate and explore action through trying and acting out, which might generate new knowledge about what is to be designed. The tools and techniques include e.g. probes and puppets that are meant to support and facilitate acting, improvisation and playing. Enacting techniques can both be part of a work-in-progress or used to present a finished design. According to Sanders et al. (2012) the combination of telling and enacting through enacting scenarios is a very powerful tool for imagining and exploring possible futures.

Generative tools in co-design: Probes, toolkits and prototypes

Besides the three toolboxes, there are also three distinct approaches to making in co-designing that have evolved over time since the 1980s and 1990s: *cultural probes, generative toolkits and prototypes* (Brandt et al., 2012; Sanders & Stappers, 2014). All three approaches make use of the different types of co-designing tools and techniques and are used in the telling, making and enacting activities.

Cultural probes are used to make non-designers (e.g. future users) reflect upon and express their feelings, experiences and opinions to inspire the designers (Gaver, Dunne, & Pacenti, 1999; Sanders & Stappers, 2014). The cultural probes were originally developed at the Royal College of Art, London in the second half of the 1990s as a means to collect samples of culture, but are today widely used in European design research (Koskinen et al., 2011). According to Sanders and Stappers (2014), probes are proclaimed 'as artistic proposals to evoke inspiring responses from individual participants, with designers using the responses at their own discretion' (p. 8). The probes can take a variety of forms such as postcards, games, diaries, workbooks, cameras with instructions etc. and are often left behind and returned later, meaning that the non-designers will work with the probes independently and return them to the designers after use. The probes are used to create an understanding of the local culture that can help form the design to meet the known as well as the unknown needs

of the users. In a co-design process there is a risk of non-designers constraining the final design by focusing only on the needs or desires they already understand, but the probes make it possible to acquire knowledge about the hidden needs and desires as well and move towards unexpected proposals.

Generative toolkits are often used in the front end of the design process to help non-designers imagine and express their own ideas about the way they want to live, work and play in the future (Brandt et al., 2012; Sanders & Stappers, 2008). They are typically used in facilitated collaborative activities and follow a deliberate and steered process of facilitation, participation, reflection, discussion and bridging of visions, ideas and concepts for the future. The process results in artefacts and descriptions or enactments of their use, which can then be analysed to find an underlying pattern (Sanders & Stappers, 2014). The toolkits are made up of a variety of components that in combination can show an infinite variety of expressions about future ways of living, and each toolkit is specifically developed for the individual project to make artefacts about or for the future. It can be 2D and 3D components such as pictures, words, phrases and all kinds of materials to build with. A good set of generative tools provides ambiguity to non-designers in order to evoke thoughts and feelings that they normally do not talk about (Brandt et al., 2012).

Cultural probes and generative toolkits are design-led and often-used approaches in co-designing. Although the methods, tools and techniques used in the probes and the generative toolkits take place almost simultaneously in the design process and overlap to a large extent, Sanders and Stappers (2014) still distinguish between them, claiming that the most important difference is at the level of mindset.

The last approach defined by Sanders and Stappers (2014), the *prototypes*, differs from the above-mentioned approaches in both format and placement in the design process. The prototype is here understood in a broad sense as the first of its kind, a preliminary model of something, which means that it can take place not only in space as a physical object but also in time as storytelling and scenario-building (Sanders, 2013). Participatory prototyping can be used to make sense of the future in the early front end of a design process by exploring, expressing and testing hypotheses about future ways of living or it can be used to create representations of future objects in the

form of mock-ups and models when the object of design has been identified (Brandt et al., 2012; Sanders, 2013). Sanders and Stappers (2014) (referring to a paper by Stappers in 2010) describe how prototypes can provoke discussions, allow for hypothesis testing, confront theories and the real world and maybe even change the world because they allow people to experience a situation that did not exist before.

According to Sanders and Stappers (2014), the three types of co-design tools are often used in specific parts of the design process, as shown in Figure 14.
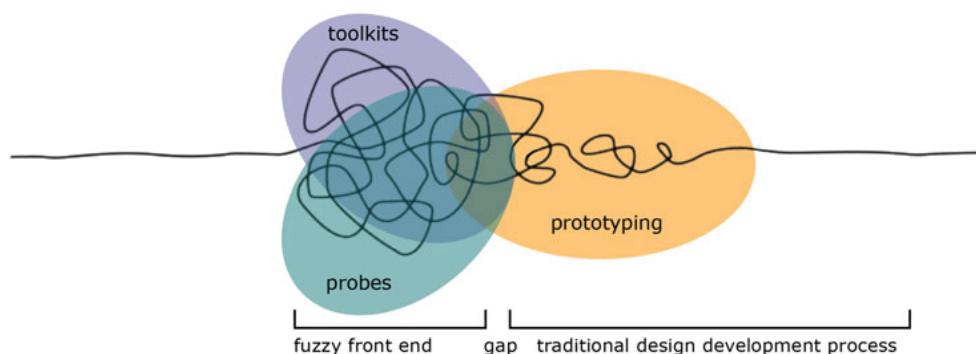
Figure 14. The position of the three co-design approaches, probes, toolkits and prototyping in the design process according to Sanders and Stappers, 2014

The diagram shows that probes and toolkits are mostly used in the front end of the design process before the actual design opportunity is established, whereas the prototypes are usually put into action right before or once the actual design project has started.

The potential of co-design in this research project

In a co-design process, non-designers (in this project, teachers, students and the school management) are actively involved in the co-design activities as they explore what to achieve and how to achieve it in collaboration with the designers. In relation to physical learning environments, this means that the end users (mainly teachers and students) are given the position of 'experts' of their teaching and learning experiences and become central participants in the process of designing and appropriating new learning space designs. This approach calls for a closer collaboration between creators

and users of learning spaces, which potentially helps align space and practice.

When designing, the designer attempts to imagine new possibilities and new futures. The same goes for co-designing with the only difference that the attempts are made in collaboration with the non-designers. However, as Sanders (2013) points out, knowledge is only present in the form of knowledgeable people, which is why co-design techniques and tools to support co-design activities are necessary in order to support all participants in the creative processes of imagining the future. It is difficult to imagine what you do not know, which is why people often refer to well-known objects when asked for their needs and ideas in a regular design process, e.g. when designing a new learning space. Co-design tools can help push the discussion beyond the already known and support the process of imagining new possibilities and new futures, because it lets you play and explore through activities and materials. It thereby helps the designer and, in this case, me as a researcher to collect information and to identity problems.

Co-design actively engages the participants in the design activities and makes them a part of the design process. In her PhD thesis 'Material Matters in Co-designing' (2012), Mette Agger Eriksen explains how co-design has played a central role in the processes of creating and maintaining engagement, alignment and shared ownership in all the projects in which she has participated. This ability to engage and create ownership is also one of the reasons why I have chosen a co-design approach in this PhD project. As proposed earlier in this thesis with reference to current research into learning spaces, the design of a new learning space does not by itself change the way the users teach and learn. A participatory process with a co-design approach has the potential to engage, inspire and create ownership for the new learning space design by including the users in the design process and help them actively participate in the making of and transitioning into the new spaces.

Furthermore, co-design can potentially help people become more creative. Not all people see themselves as creative and might have trouble putting words to or visualise their thoughts and needs, which is where co-design tools are believed to be valuable. Through my work at Rune Fjord Studio, both before embarking on this research journey as well as during the PhD project, I have more than once heard participants in

participatory design processes claim that they 'are not creative' or that 'their brains do not work that way'. Co-design tools might help these people become part of the creative process by supporting and forcing them to think differently.

Finally, co-design has 'the potential to initiate a discussion about abstract pedagogical philosophical issues through a very concrete subject like e.g. the layout and experience of a learning space' (Bøjer, 2018). Co-design tools create a language that helps the diverse participants communicate, e.g. through visualisations and enactment (Sanders, 2013). This has proved very valuable when working with the students and teachers in experiment #2.

In summary, co-design tools have played three different roles in this project:

- As a tool to gather information that feeds back into the research project / research method
- As a tool to gather information that feeds back into the designing of the prototypes and the innovative learning environment in experiment #1 / design method / pre-designing
- As a discussion tool to create environmental awareness and competence and activate the learning space in relation to pedagogical practices in experiment #2 / post-designing

This means that co-design toolkits and techniques have not only been used in the front end of the design in this research project, but also in a post-design phase separated from the design process. As mentioned earlier, this is not common in co-design. However, as this thesis demonstrates, co-design has a wide potential as an approach and a tool in post-design phases (e.g. transition and consolidation phases) of learning environments.

Data collection and analytical tools

This research project is a qualitative study. It is conducted as constructive design research, taking a programmatic approach to design research with an overall research program and three design experiments that dynamically interact and inform each other. The dialectic relationship between program and experiments is used to create answers to the research questions, as explained in the previous sections of this chapter.

The objective of this project is to create knowledge about the interplay between learning space design and pedagogical practices and the role of the stakeholders (in particular the users) in the design process of new learning spaces, before, during and after the design and implementation of new learning spaces.

The outcome of the research is informed by both literature studies and findings from the experiments. The design experiments and literature studies were conducted simultaneously and concurrently, thus influencing each other. The literature studies continuously informed the design experiments as new research was discovered, whereas the design experiments sometimes pointed in new directions that were subsequently followed up in the literature studies. Furthermore, the design experiments evolved iteratively. This is common procedure, according to Brandt and Binder (2007), who explain that design experiments can be re-interpreted as they are documented and unfolded during a research process.

The research methods used to collect data were generative research methods based on design practice (e.g. co-design activities, architectural drawings, design processes, photomapping, and logbook for reflection in and on action) as well as more traditional methods such as semi-structured interviews and observations.

The main research methods differed slightly in the experiments: In experiment #1, data was mainly collected through the design activities, observations, photo mapping, architectural drawings and unstructured interviews (such as talks and email communication with a teacher and the vice principal and meetings with the school management). In experiments #2 and #3, the main research methods for collecting data were the co-design activities, photo documentation and semi-structured interviews. Furthermore, I used a logbook to document reflections and activities during all three experiments.

Co-design as a research method

In the previous sections, I have explained co-design as a design and research approach and the various roles of co-design in this research project, including being a research method for data collection. In all three design experiments, data was collected through a mix of designerly tools, mainly consisting of toolkits and workshops. The

co-design tools served to make the participants reflect and discuss the relationship between space and practice, which was documented using post-it notes, pictures and a broad selection of materials. These documentations were subsequently gathered and analysed as part of my research process. During the experiments I also wrote a logbook to note observations and reflections as they emerged during the co-design processes and activities.

Interviews

Data was also collected through different types of interviews in all three experiments. Interviewing people about their experiences, opinions, attitudes and life situation is a widely used qualitative research method in both human sciences and social studies. According to Tanggaard and Brinkmann (2015a), when competently done, it is one of the most important and effective means of understanding people.

There are many ways to conduct research through interviews, e.g. person-to-person, in groups or digitally and the interviews can be unstructured, semi-structured or strictly structured. The most commonly used interview type in modern research is semi-structured interviews in which the interaction between researcher and informant takes place as a dialogue based on both planned and unplanned questions. The interview is often recorded and later transcribed (Tanggaard & Brinkmann, 2015a). This is also the primary interview type used in this project where semi-structured individual interviews with the involved teachers provided information about their experiences in relation to the co-design process in experiment #2 and the co-creation furniture in experiment #3. In the first experiment, the interviews were mainly conducted as simple questions sent by email or as unstructured interviews during meetings with the school management or informal conversations with the teachers.

Importantly, the interview is not to be considered a neutral technique to gain unaffected answers from the informant, according to Tanggaard and Brinkmann (2015a). Instead, they claim, the interview should be seen as an active interaction between two or more people that leads to socially negotiated and context-based answers. This means that I, as an interviewer, affect the results through my questions and my relationship with the informant.

Since people primarily talk about their actions and experiences during interviews, Tanggaard and Brinkmann recommend mixing interview research with other research methods, e.g. field work where people's actual actions are observed. Referring to Kvale & Brinkmann (2009), they emphasise that interview research is particularly suitable for illuminating relational, conversational, linguistic and narrative areas of the human experience (Tanggaard & Brinkmann, 2015a).

Participant observation and other ethnographic tools

In addition to the designerly tools and the interviews, I also used ethnographically inspired tools to collect relevant information. These tools are for example observations (Szulevicz, 2015) and photo documentation (Holm, 2014). Szulevicz (2015) describes observation as a well-established qualitative method, used especially within anthropology but also more widely in qualitative research. Observations can assume many forms and have very different purposes. Still, according to Szulevicz, it is possible to distinguish between two types: experimental and participant observation. The first type, experimental observation, takes place in a lab or otherwise defined setting, where unintended incidents and unwanted impacts on the observations can be minimised. In the second type, participant observation, the researcher participates in the observed practices as the observations take place amongst people in their own surroundings and with a more or less intense social interaction between the researcher and the examined environment. Participant observation is not without complications and is almost paradoxical, according to Szulevicz, since participant means active involvement in a practice and observation means the opposite. As a researcher doing participant observation, you do both at the same time: sometimes the researcher takes part in the activities and at other times, she dissociates herself from practice and observes. The observations can take place over a longer or shorter duration; what matters is that the empirical material is based on presence and first-hand experiences (Szulevicz, 2015).

In this research project, I have used participant observation in all three experiments as I took part in the activities of the experiments and observed the use of the space and the furniture (experiments #1 and #3) and also participated in the discussions

and the work during the workshops (experiment #2). According to Szulevicz, participant observation as a research method fits well with research done following the topographic turn, which represents an orientation within the human sciences towards an understanding of social relations as taking place in physical and concrete spaces. The topographic turn is a response to the literary turn, where focus lies on the understanding of the world as a narrative and discursive construction, and it is characterised by a preoccupation with the interaction between the sociocultural and the bodily elements in concrete, material frames (Szulevicz, 2015). This corresponds well with the understanding of the relationship between space and practice in this research project, which is examined as a socio-material interplay, where each part, design and user affects the other. For this reason, participant observation has been experienced as a valuable research method in interaction with the designerly tools in all three experiments.

Furthermore, photos have been used to document and map for instance the physical design of the learning spaces before and after the redesign process, the co-design activities during the workshops and the independent use of the co-creation furniture by the teachers. According to Holm (2014), the use of photo documentation as a qualitative research method has a long history in many research fields such as anthropology and social sciences. She explains that photography can be considered a data collection method; however, the use of photographs as a research method is complicated by the ambiguity that exists in photographs. Photographs are never completely objective but always portray a constructed view of reality (Holm, 2014). However, I will argue, in this research project this is outweighed by the use of photo mapping and documentation in interaction with other research methods. The photographs were taken both by me (and my associates at Rune Fjord Studio) as well as the participants, thus portraying both the researcher's and the practitioners' view as well as the participants' view on selected issues and activities.

Other documents used to collect data in this project were architectural drawings by Rune Fjord Studio showing for example the flow in the original space as well as meeting protocols from meetings with the school management and other stakeholders during the redesign process in experiment #1.

According to Stender (2017), using ethnographic methods is a way to discover unacknowledged needs and everyday practices that people are not necessarily aware of themselves. As claimed earlier, this is also a characteristic of co-design, where the future is addressed through co-design activities. However, I will claim that ethnographic methods are to a larger extent aimed at discovering needs and practices as they are, whereas co-design also focuses on needs and practices as they ought to be in the future. Thus they supplement each other very well in this project. The ethnographic methods have been used to obtain knowledge on what the participants in the experiments did, i.e. how the space was used prior to and after the redesign process in experiment #1, whereas the co-design tools even provided information on how the participants envisioned the use of the spaces in the future.

Classroom

Classroom

Classroom

Special
education

Storage

Storage

Freetime club

Classroom

Special
education

Classroom

Classroom

Classroom
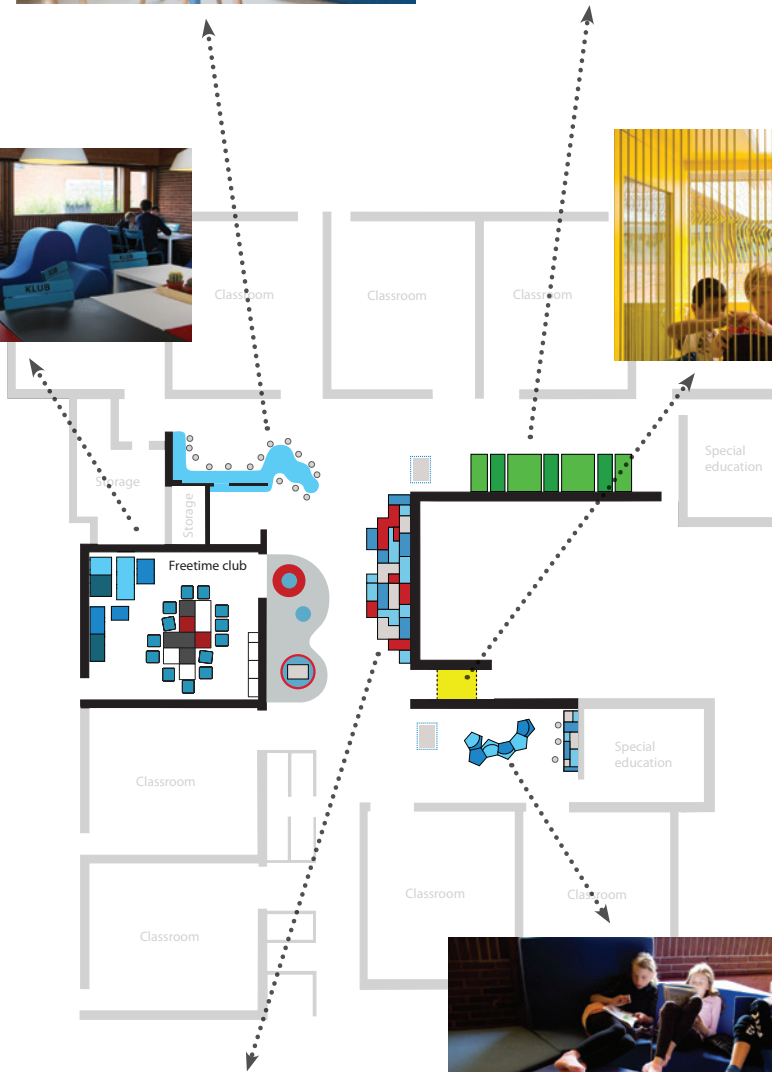
5 // THE DESIGNERLY EXPERIMENTS

Chapter 5 presents the empirical work conducted in this research project from design experiments to insights. It starts out with an introduction to the design experiments and their interrelationships, followed by a presentation of the design process from a historical perspective and as it is featured in this project. This section also positions the research project in a design methods tradition. Subsequently, the chapter is divided into three main parts, each presenting and discussing an experiment. Overall, the design experiments explore three designerly ways to influence the interplay between learning space design and pedagogical practice, focusing on the design process, the design tools and the design (prototypes), respectively. Succeeding the experiments, the concept of participatory activation is suggested and discussed in relation to both the findings from the experiments and current research.

THREE DESIGNERLY WAYS TO INFLUENCE THE INTERPLAY BETWEEN SPACE AND PRACTICE

This chapter reports on three experiments conducted in the period 2016-2018 in two Danish schools, School A and School B. The experiments were conducted in an iterative but non-linear process, where the first experiment assisted in framing the initial program and led to the formulation and development of the other experiments. This is what Krogh et al. (2015) call the expansive method, as explained in chapter 4. The findings from the first experiment slightly changed the program from focusing only on the design process of a new learning space design to also including an activation phase after the implementation of the final design, thereby attempting to widen the perspective of the designer's praxis corresponding to the expansive method.

The experiments have been used to both challenge and substantiate the research by exploring different aspects of participatory design processes of learning spaces and their significance for the interplay between learning space design and pedagogical practice. In particular the first experiment was found to challenge the initial program and suggest an additional focus on the space-practice relationship following the implementation of a new learning space design.

The overriding aim of all three experiments has been to answer the main research question of this thesis: *How can participatory design processes and tools inform the interplay between learning space design and pedagogical practice?*

Overall, the experiments examined three designerly ways to influence the interplay between learning space design and pedagogical practice in relation to the design process. As such, the experiments made use of three different types of constructions, as proposed by constructive design research, the design process, the design tools and the design in the form of two prototypes of furniture.

The first experiment explored the design process in school A and the significance of stakeholder participation in relation to the actual use of the learning space design after implementation.

The second experiment explored the use of participatory design tools in a post-design activation phase of learning space designs. In a workshop course in school B,

co-design tools were examined as discussion tools to create environmental awareness and competence and through this improve alignment between space and practice. The aim was to explore whether co-design can be used to activate a learning space in relation to pedagogical practices and thereby help users transition into new spaces.

The third experiment explored and compared the use of two sets of furniture prototypes, called co-creation cabinets. The aim of this experiment was to examine the role of activation versus non-activation of new learning space designs (furniture) and took place in school A as part of experiment #1 and in school B as part of experiment #2.

The findings from the experiments contributed to the development of a design process model, where an additional post-design activation phase has been added to the process following the implementation of a new learning space design and to a new concept proposal that takes place during this additional phase, 'participatory activation'. This will be elaborated on later in this chapter as the three experiments unfold. The experiments were conducted in collaboration with my colleagues at Rune Fjord Studio. When talking about 'we' instead of 'I' in this chapter, I therefore refer to both my colleagues and myself.

The chapter is divided into three subchapters, addressing experiment #1, #2 and #3, respectively. First, though, I will briefly introduce the development of research in design methods in order to position this thesis in a design research tradition.

THE DESIGN PROCESS, HISTORICALLY AND IN THIS PROJECT

The process of designing is a dynamical and much discussed field in various contexts, which is why a large amount of both practices and theoretically anchored approaches and positions exist. The first academic conference on design methods took place in London in 1962 and has been marked by e.g. Cross (1984) and Lundequist (1992) as the establishment of the so-called Design Methods movement. Today, the field of research in design methods constitutes a heterogeneous area with many theoretical positions and methodological practices.

Several meta-studies on the movements in the research of design methods have divided the development into generations of design methods with varied focuses and objectives (e.g. Archer, 1981; Cross, 1984, 1993; Engholm, 2011, 2017; Lundequist, 1992). Based on these meta-studies, in particular Engholm (2011, 2017) and Lundequist (1992), I will pinpoint the approaches that underlie the methods chosen in the experiments in the following.

Across the meta-studies, three generations of design methods have been identified through which the attention shifts from design methods to the context and conditions for design development (Engholm, 2017). The 'first generation methods' (as labelled by Cross, 1984) began with the first conference on design methods in 1962 and was aimed at systematising the design process with theory and methods to guide practice (Engholm, 2011). According to Engholm (2011, 2017), the generations advanced from an understanding of the design process as linear and problem-solving in well-defined stages in the first generation (1960s) to viewing the design process as a process of negotiation through iterative approaches and argumentative methods in the second generation (1970s). Finally, in the third generation (1980s and forward), the general and prescriptive methods were abandoned in favour of an acknowledgment of the singular and situative character of design problems and design tasks. Lundequist (1992) elaborates on this by explaining that the first generation (e.g. Jones, 1992) believed in systematic methods based on mathematical-logistic theories and viewed the designer as a scientifically trained objective expert, a notion which the second generation (e.g. Newell & Simon, 1972; Rittel & Webber, 1973) rejected in favour of a dynamic design process with user involvement as a key concept. The role of the designer also changed from objective expert to an educator whose task it was to release the user's ideas and demands. The third generation (e.g. Cross, 1984; Lawson, 2006; Schön, 1983) was characterised by a new understanding of design and design processes as a particular way of thinking that required its own methods.

The point of departure of the experiments in this PhD project is the assumption that design processes are iterative and dynamic and have to be adapted to the particular context and situation in which they take place, much like the assumptions of the third-generation methods. At the same time, the project takes on a participatory

approach, in line with action research, constructive design research and co-design, by assuming that the designer must enter into close collaboration with the future users of the learning space design by involving them actively in the design process in order to match design and actual needs. Thus, this research project is positioned between the third generation design methods and an open and collaborative design approach as found in constructive design research and co-design (e.g. Brandt et al., 2012; Sanders & Stappers, 2008). The latter can be argued to be part of a fourth generation of design methods, where the focus is on open, dynamic, collaborative and co-creative design processes. In the experiments of this research project, I will draw on theoretical insights from both generations as I combine a third-generation design process with a co-design process.

In relation to the experiments, I have chosen to work with a fairly traditional design process model as a visual tool, which is inspired by the Double Diamond (Figure 15) developed by the British Design Council (Council, 2007). In order to visualise the design process in a simple graphical way, the Double Diamond maps a rather linear and well-structured user-centred design process in four stages. However, this is a construction, and in reality the process is assumed to take place as a repeatable loop, thereby linking the Double Diamond to the iterative and dynamic processes of the third-generation design methods.
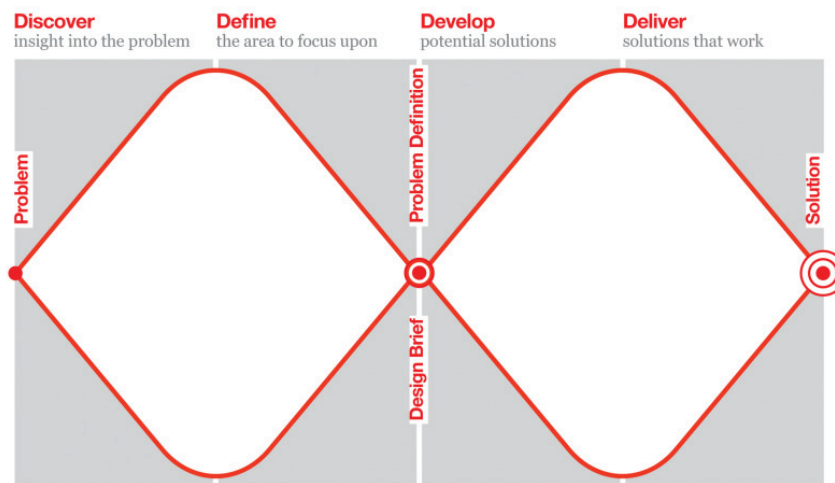
Figure 15. The Double Diamond model by the British Design Council, 2007

The Double Diamond was chosen as an inspiration source for the design process in school A (experiment #1) because of its clear visualisation of the structure of the design process, which made it easier to communicate the design project to the stakeholders. The Double Diamond model was even selected for its visualisation of the mindset of the designer and co-designer, shifting between divergent and convergent thinking in the process of designing. This was found to support the designers in knowing as well as communicating the type of actions required for the non-designers in the process (e.g. opening up or narrowing down ideas). Moreover, the model's four phases corresponded with the established practices at Rune Fjord Studio before the start of the research project and thus provided an element of safety in the design process. As such, the model worked as a tool for controlling, communicating and visualising the design process both externally to the stakeholders and internally in the design studio.

In my research, I added an additional layer to the traditional design approach by using the constructive and programmatic approach as a driver in my research process and as a means to sharpen my research inquiry and research questions. Furthermore, I used co-design as a means to stimulate the collaborative element otherwise missing from a traditional design process as visualised in the Double Diamond.

In reality, the design process did not proceed in such a linear and assembled fashion as visualised in the Double Diamond. The design process of the learning space in experiment #1, and arguably many design processes today, was much more dynamic and deconstructed in its attempt to involve the stakeholders and design a fitting solution. Thus, the abstract design process model by Bryan Lawson (2006) in Figure 16 might be more representative of this type of participatory design process as it visualises the design process as a negotiation between problem and solution through the activities of analysis, synthesis and evaluation. These components or activities constitute both the actions and mindsets which the designers and the participants alternate between in the process of designing. According to Lawson, it is not possible to develop a universal model (or map, as he calls it) for the design process as it will always simplify a highly complex mental process. Therefore, his model should not be interpreted too literally. Instead the design process should be understood as a dynamic and deconstructive process with no set starting or finishing point, where the design

activities can be composed and overlap in many different ways and where there is no direction of flow from one activity to another. Therefore, Lawson's model accentuates the situative character of the design process, which has to be adapted to the actual context and the participants involved in the process.
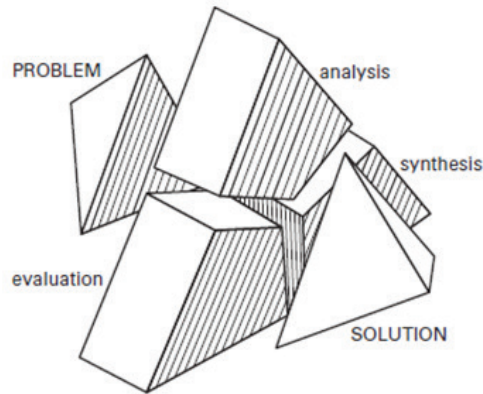
Figure 16. The design process model by Bryan Lawson from How Designers Think, *2006, p. 49*

Although the actual design process and the manner in which Rune Fjord and I acted as designers and facilitators during the design process at school A resembled the illustrated process by Lawson (2006), we still chose to use the more traditional visualisation of the design process as a sequential, linear structure as an internal and external communication tool. The simplicity and transparency of the linear model was assumed to be easier to understand and communicate to the stakeholders and its resemblance to a classical project management process could potentially create a sense of trust and security. Easy communication was found to be very important as the research was conducted in the local context of the school with the local 'inhabitants' (school management, teachers and students) as co-researchers—as is typical in action research.

This research project was also inspired and informed by a design process model by Sanders and Stappers (2008), depicting a participatory design process as shown in Figure 17. In this model, Sanders and Stappers (2008) visualise the complexity of the pre-design phase or 'fuzzy front end', as they name it, and how this concept plays a large role in the co-designing process. Contrary to the traditional user-centred

design process, which usually starts with the identification of a problem after which the designer comes up with an idea to a solution, the co-design process opens more exploratively with the users and designers collaboratively exploring and identifying both problems and potential solutions simultaneously in search of an imaginary future. In the fuzzy front end the aim of the design process is explored and determined in a joint designer-user collaboration after which a more traditional design process follows but with extended user involvement. Thus, the role of the user also differs in the two processes. In the traditional design process, the user is mainly a study object or an informant, who provides information that the designer can utilise to generate ideas and concepts and finally design a product to fulfil the needs of the user. In the co-design process, the roles are mixed up as the designer works closely together with the user, who, as an expert of her own experiences, becomes a co-designer in the design process. Thus, in co-design it is also very important to provide a transparent design process that is easily understood by the participants. The designer still plays a critical role in the process, both by providing tools for ideation and expression as well as giving form to the ideas.
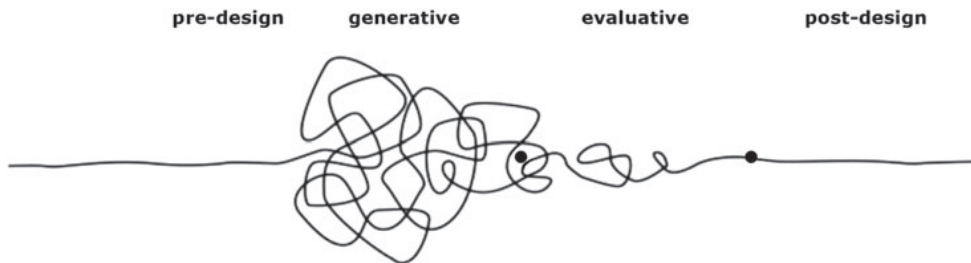
Figure 17. Illustration of the design process with a 'fuzzy front end' by Sanders and Stappers, 2014

As explained by Eriksen (2012), traditional design processes are often visualised as linear process models (from research through idea-generation and design to implementation as in the Double Diamond), whereas co-design processes are commonly viewed as iterative with shorter repeated design cycles building on previous cycles. As the designers move closer to the future users of the 'things' they design, the fuzzy front end of the design process grows.

In experiment #1, the involvement of the users was believed to be highly important for the success of the project. Since the main purpose of the project was set from the beginning, the fuzzy front end was rather small and a traditional third-generation design process matching current practice at Rune Fjord Studio was attempted merged with a participatory fourth-generation design process. This turned out to be rather complicated, relating to the organisation of the school as well as time and budget limitations in the design project, which will be discussed in the following. Hence, the design process ended up being more on the traditional side. Based on the findings from the first experiment, the design process was rethought and an additional phase was suggested as an addition to the design process model adapted from the Double Diamond. The proposed fifth phase is assumed to take over where the other design process phases end. I will return to this after experiment #1.

EXPERIMENT #1 / THE DESIGN PROCESS

An initiating experiment

In 2016, Rune Fjord Studio was asked to design a new learning space in a public school near Copenhagen built in the 1970s, school A. The learning space was to be located in a common street-space connecting to nine classrooms (called department B) used by 3rd to 5th grade students (approx. 250 students). The term 'street-space' is described by Dovey and Fisher (2014) as an open learning space, big enough for activity and circulation, which is exposed to major traffic as the primary access to other learning spaces. As a street-space, the new learning space in school A was an addition to the regular classrooms surrounding the space (Figure 18).

Figure 18. The original street-space and the adjoining classrooms

The main part of the funding for the redesign came from a public grant to establish an

afterschool club as a 2-year pilot project. Therefore, the new premises were required to include two main functions: they were to be used as a break-out space during school hours and for leisure activities in the afternoon. For this reason, it had to offer areas for both formal and informal learning activities as well as free play and was designed as an innovative learning space. According to Mahat et al. (2018), an innovative learning space is designed and built 'to facilitate the widest array of flexibility in teaching, learning and social educational activity'(p. 8).

As part of this commercial project, I initiated experiment #1 and later experiment #3. The aim of experiment #1 was to explore stakeholder participation in the design process and its significance for the interplay between the final learning space design and pedagogical practices. In other words, how could we involve the stakeholders in the design process and what did this mean for the actual use of the space after implementation? Hence, the research question for this particular experiment was: *What is the significance of stakeholder participation in the design process for the alignment of learning space and pedagogical practice?*

Experiment #3 was looking at a similar topic as it explored the relationship between user participation in the design process and the actual use of two furniture prototypes, the co-creation cabinets, by comparing the use in two schools. Its main aim was to examine the difference in use of the cabinets in the two schools in order to create knowledge regarding non-activation of learning spaces (school A) versus activation of learning spaces (school B). This will be discussed later in this chapter in the section concerned with experiment #3.

The experiment (and the entire design project at school A) was based on three interconnected assumptions that arose from the theoretical reflections in chapter 3:
1. Space supports pedagogical practice but does not automatically change practice;
2. Stakeholder participation in the design process is important for the alignment of space and practice and;
3. The use of the space depends on the alignment of the design of the physical space, the pedagogical practices and the organisation of the school.

During the design process we experienced stakeholder participation to be rather complicated. For various reasons, which I will elaborate on later in this chapter, it

turned out to be difficult to involve the teachers in the design process. This resulted in a big gap between the intentions behind the learning space design and the actual use. The space ended up being used completely contrary to the intentions for more than one year after implementation. I uncovered this through observations and communication with teachers and school management on several occasion in 2017 and 2018. It was not until the school management started to control the use of the space and have regular discussions regarding the use of the space during team meetings and a teacher was assigned hours to try to change practice that the teachers started to use the space more in accordance with intentions and affordances of the spatial layout (teacher, personal communication, March 7, 2019).

The findings from this experiment indicate a connection between failed user involvement in the design process and a subsequent mismatch between the spatial design and pedagogical practices. The teachers never really took part in the design process despite being invited to participate and were expected to learn how to use the space on their own by the school management. This failed and the teachers instead retreated to old practices that did not match the new spatial setting.

As the experiment shows, participatory design processes can be complicated and difficult to complete, which poses a risk to the alignment of space and practice. Based on this, a new assumption was made that inspired and formed the succeeding experiments:

4. Participatory design of new learning spaces is not always enough to assure the alignment of space and practice.

To meet this challenge, I propose an additional activation process after the implementation of a new learning space design, where the intentions of the new learning space are translated into actions and negotiated through appropriation with the users. The purpose of this phase is to match practices with spatial possibilities, which is explored in experiment #2.

To use the term by Bang and Eriksen (2014), experiment #1 became an 'initiator framing the research program'. The findings from the experiment made the program drift as focus changed from only participation in the design process to include a prolongation of the design process with an additional activation phase after

implementation.

In the following, the course of experiment #1 will be discussed in relation to the theoretical and methodological framework from chapters 3 and 4. Subsequently, the findings from the experiment will be analysed and discussed in order to identify and define the issues that have led to the development and definition of experiments #2 and #3 and their sub-questions.

The design process at school A

The design process was planned to proceed in four phases as shown in Figure 19 and thus resembled the traditional user-centred design process presented earlier. The graphic representation of the design process mainly served as a visual tool to keep track of when to involve the different stakeholders in the project and to communicate the project internally and externally as explained earlier. The process model was inspired by the Double Diamond (Council, 2007), which was chosen for its visualisation of the different phases of the design process and the way they respectively open and close the process through divergent and convergent thinking. Furthermore, the four phases of the Double Diamond corresponded with the actual design process at Rune Fjord Studio, which had been used for many years.
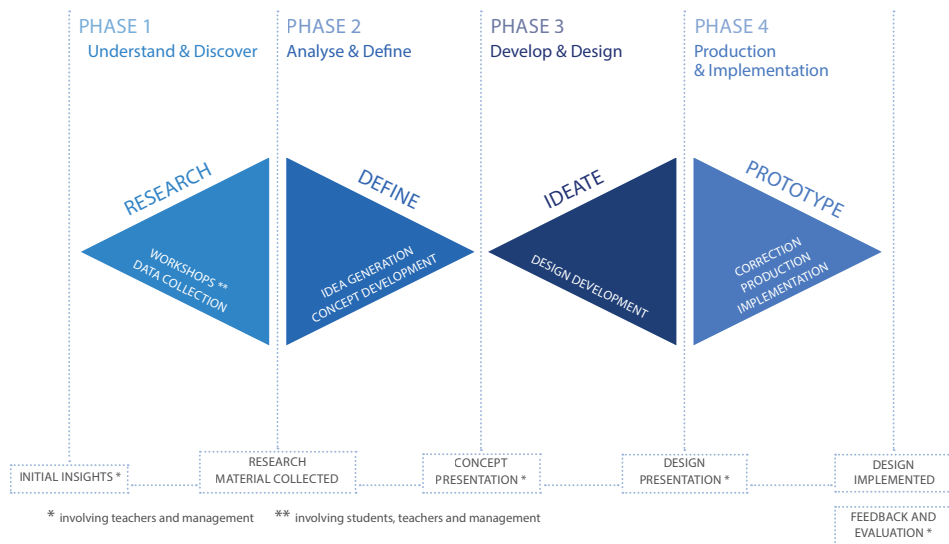
Figure 19. The final model of the design process in experiment #1

The design process at school A was therefore divided into four phases, which I have chosen to call Understand & Discover, Analyse & Define, Develop & Design, and Production & Implementation in my process model. The titles are chosen for their ability to explain the main content of each phase in a more explicit manner than in the Double Diamond as they relate to the praxis of the particular phase. The fuzzy frontend is lacking from this model as the main aim of the project was determined before we received the assignment. As a supplement to the original model, I added particular touchpoints for user involvement in the new process model to visualise and keep track of the collaborative element.

The process began with an email correspondence between the principal of the school at that time and me in June 2016. We had worked together two years earlier when Rune Fjord Studio designed an activity-based teachers' lounge following the new school reform in 2014 and the lounge had become very popular amongst the teachers. Hence, the principal now invited us to design the new learning space featured in this chapter. Before starting the design process, however, the principal was offered a new job and stopped working at school A and a provisional principal was installed. He was later appointed to the position, but we felt that he never really took ownership of the redesign project.

The assignment was quite clear from the beginning, so the design process began with a research phase, where we met with the school management and facilitated two workshops with the staff and with students and their parents, respectively. We also made photo mapping and observations in the space (one day, three people). After gathering as much information as possible, we moved on to the second phase to narrow the scope of the assignment and match the space and requests concerning practice in a concept proposal. The concept was then presented to a couple of stakeholders from the municipality and the school management, who in turn presented it to the staff at the school. Based on their feedback, the concept proposal was turned into a design proposal and presented to the school management and a couple of stakeholders from the municipality. Once more, the school management took care of the presentation of the proposal to the rest of the staff. Some parts of the design proposal were cut because of budget limitations prior to production. Finally, the design was implemented

and the space was gradually taken into use during this phase. One month after the official opening of the space, in June 2017, we evaluated the project with the school management.

Structure of the experiment

Time frame of the experiment

The design process proceeded from August 2016, when the first meeting with the school took place, until May 2017 when the afterschool club officially opened. Since the experiment explored the design process and the significance of stakeholder participation in relation to the actual use of the learning space design after implementation, the time frame of the experiment followed the design process (Figure 20). It even proceeded after the design process as observations and meetings with stakeholders were conducted subsequently. Furthermore, attempts were made at establishing a second experiment at school A aiming to activate the new learning space, but this was never realised. In the spring of 2018, the school was offered a process similar to the co-design process in experiment #2 (free of charge) and in May 2018 I met with a teacher to discuss the project. Despite being really interested in the process, the teacher did not manage to find the time to participate until the spring of 2019 and by then I was deep into my thesis writing process.
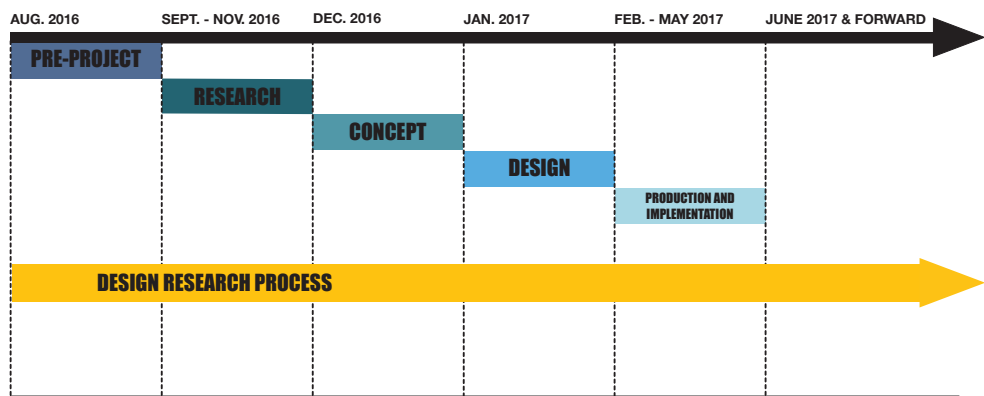
Figure 20. The diagram shows how the research process followed
the design process and continued afterwards

I have chosen to treat the design process as one collective experiment (hence one section in the thesis) as I am interested in the relationship between the participation (or lack of participation) of the stakeholders in the design process and the actual use of the learning space afterwards. One of the main stakeholder groups, the teachers, ended up taking very little part in the design process and it is therefore not possible to analyse the connection between the individual activities of the process, e.g. the workshops, and the subsequent use of the space. For this reason, looking at explicit and detailed ways to involve the users in the design process is irrelevant in this experiment. This explains why the individual activities are not considered as individual experiments.

Stakeholders & activities in the experiment

The stakeholders in the project were mainly representatives from the school management, teachers, pedagogues (in Denmark a pedagogue is educated to work with children, youths and adults in e.g. kindergartens, after school clubs or residential institutions), students, parents and representatives from the municipality. Stakeholder participation was planned to take place regularly as shown earlier in Figure 19. Most user involvement was planned in the first phase of the design process and the main methods of involvement were workshops and meetings. Furthermore, a document for recording the spatial use was handed over to each teacher, but only a few returned the paper and hence did not supply additional information on the actual use of the space. Instead, it contributed to the experience of lack of teacher engagement in the project and supported the finding that user involvement in the design of learning spaces is complicated.

Documentation setup and data analysis

The research material was collected using various methods such as photomapping, architectural drawings, observation, informal interviews, meetings and documents for recording the spatial use by the teachers. The diagram in Figure 21 shows an overview of how and when data was collected. Much data was collected in the first phase of the design process. Throughout the design process and even after, I kept an eye on the use of the space and the co-creation cabinets through meetings at the school with the school management, a meeting with a teacher, several observations

and informal talks with teachers and pedagogues whenever I visited the school and through mail communication with the vice principal and one teacher (Appendix 1). Observations were done on four occasions, in the first phase of the design process to collect information regarding the use before designing, during the design process and then approximately 3 and 6 months after implementation to observe the use of the new learning space design. Furthermore, I kept a logbook throughout the project, where activities, reflections and communication with the school management and teachers were recorded. The documentation process continued after the termination of the design process.

YEAR	2016					2017												2018							2019
MONTH	Aug	Sept	Oct	Nov	Dec	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Marts	April	Maj	Juni	......	Marts
Meeting school management	x			x	x	x			x		x							x							
Meeting teacher/pedagogues													x												
Meeting teacher C																						x			
Workshops				xx																					
Observations				x					x				x			x									
Mail principal	x	x	x																						
Mail vice principal			x	x				x	x	x			x	x	x		x	x				x			
Mail teacher C																			x		x				x

Figure 21. Timeline diagram presenting workshops, observations, meetings and informal interviews during the design and research process at school A. A detailed diagram can be found in Appendix 2.

All data has been analysed through the lens of the learning environment triangle and the findings are explained relating to the three elements of the model, practice, space and organisation and their interrelations. Furthermore, the design process has been used as a fourth analytical theme. Focus has especially been on the design process and the actual involvement of the stakeholders (when and how) as well as the expectations of the stakeholders (especially the school management) compared to the actual use. Subsequently, these findings have been used to understand the connection between stakeholder involvement in the design process and the actual use of the space after the implementation of the new design.

The process of designing an innovative learning space

The triad of relationships between practice, space and organisation served as the starting point for the design process of the new learning space. To create alignment, we wanted to conduct a participatory design process involving both end users (teachers and students) and school management in the design process on a regular basis. The presumption was that this would help to continuously align the needs, wishes and

intentions and thereby assure ownership and use of the space. According to Woolner (2010) the involvement of school users in the design process tends to increase their sense of ownership of the resulting environment. Even though the positive effect of this ownership on the following use has not been tested in research, the need for ownership is accepted in literature of both design and education as an explanatory variable (Woolner, 2010) and thus also in this research project.

Unfortunately, it turned out to be complicated to accomplish teacher participation, which affected the research input in the actual design process, as I describe in the following quote:

> *The intentions were to involve all key stakeholders directly or indirectly through ambassadors during the design process on a regular basis. In reality, this was not possible, presumably because of budgets, tight deadlines and teachers' workloads. Könings, Bovill and Woolner (2017) describe how participation in the design of learning environments is crucial in order to account for the different expectations and perceptions of stakeholders, but might be limited by contrasting expertise, cultures and priorities – or in this case, project restrictions and other circumstances. Initial insights into needs, wishes, organisation and pedagogies of the municipal school were mainly obtained from the school management prior to the design process, and regular communication between school management and designers were held throughout the project. In addition to this, ethnographic methods like photomapping and observations were performed pre-designing to collect empirical data that served as a groundwork for the spatial design.* (Bøjer, chapter from the book Teacher Transition into Innovative Learning Environments *by ILETC to be published by Springer late 2019)*

As the quote shows, the contribution to the design process by the teachers was insignificant. Stakeholder participation mainly consisted of school management and representatives from the municipality (workshop 1) as well as students and parents (workshop 2). The limited teacher participation turned out to be critical to the alignment of space and practices after the implementation, which will be explained in the following sections.

The workshops

The end users of the learning space were mainly invited to participate directly in the design process in the pre-design phase. Two workshops, each of two hours' duration, were held at the school in November 2016 that included the end users and other relevant stakeholders in the design process and was meant to collect information that could lay the foundation for the designing of the space. In the first workshop, school management, teachers and pedagogues were invited to participate, whereas the second workshop was mainly targeted students and parents from the relevant year groups. However, the teachers were invited to participate in this workshop as well.

In both workshops, co-design, mainly toolkits and scenarios, was used to initiate discussions and collect information to the designers and the research project. These tools were chosen for their ability to actively engage the participants in the development of future and imaginary scenarios, in accordance with constructive design research. According to Nordquist and Watter (2017), it is a challenge to design for an unknown tomorrow and therefore not enough only to observe current practice if you want to create a learning space that fits the needs of an unknown future. As explained by Sanders (2013), co-design tools can help give words to the unknown by supporting the participants in the creative processes of imagining the future, thereby contributing both to the actual design process and the research process.

The workshops were also a way to work with the relationships affecting the upcoming learning environment. By assigning an active (although minor) role to the users as actors (in the ANT sense) in the development of the learning environment, we were hoping to create a sense of ownership and a better match between the physical design and the activities that were to take place in the space.

Workshop 1, staff (teachers, pedagogues and school management)

The first workshop took place one afternoon in November 2016 in the teachers' lounge at the school. Prior to the workshop, all affected teachers and some of the pedagogues that were to operate the afterschool club were invited to participate (not all employees for the new afterschool club had yet been assigned). The aim of the workshop was to collect knowledge and create a discussion about the actual use of the premises as well

as future spatial needs and wishes. In collaboration with the school management, we chose the following topics for the agenda in order to collect the necessary information for the design process:

- Current use and wishes for future use;
- Current pedagogical, organisational and practical procedures;
- Wishes for specific types of furniture and activities;
- The transition from school to leisure time;
- The identity of the school related to the physical environment.

Only a small group of stakeholders participated in this workshop as most teachers had declined the invitation due to coinciding school-home conversations (we were told). Hence, the group consisted of three representatives from the school management (the acting principal, the vice principal and the head of the pre-preparatory classes), three pedagogues and one teacher (from another teaching team—she did not teach in Department B). This only came to our knowledge the day before the workshop. In an email conversation from 5 Oct 2016, the principal at the time wrote (translation from Danish) 'We will bring employees to the first workshop, inviting those who are interested and approach some individuals who are probably more interested than others'. Sixteen days later (21 Oct 2016), the vice principal sent an email saying that the first meeting with teachers and pedagogues was almost 'under control'. The day before the workshop, the vice principal emailed again, writing that only one teacher had agreed to participate, but that they were hoping to get two more from the department to take part. Whether the lack of teacher participation was due to miscommunication, prioritising of working hours or lack of encouragement from the part of the school management is unknown, but the absence of teachers in the workshop presumably contributed to the failed alignment. The lack of teachers in the workshop meant that the priorities and needs of the afterschool club came to dominate the discussions as well as the list of functions and activities.

The lack of teacher participation in this workshop illustrates the general challenges concerning user involvement and change processes that change agents face in the process of implementing new practices. It also suggests that a strong organisation leading the process is of high importance. Returning to ANT, the relational ties within

the network of the design process changed as the teachers were not involved, which potentially led to a mismatch between space and practice. This imbalance in the relationship between practice, space and organisation is visualised in the triangle in Figure 22.
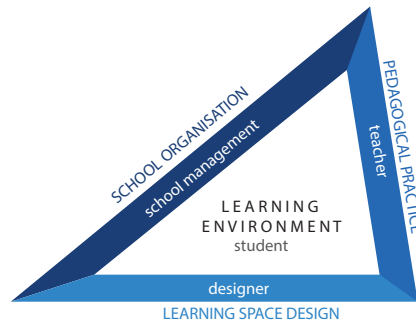
Figure 22. The lack of teacher participation in the design process created an imbalance in the relationship between practice, space and organisation

Workshop 2, students and parents

The second workshop took place one week later on the actual premises where the new learning space was to be established. Approximately 30 students and parents participated in the second workshop, primarily from year 3. A few came from year 2 and 4. In addition, the acting principal, vice principal and the head of pre-preparatory classes also participated. A pedagogue and one or two teachers were also supposed to join the workshop, according to the vice principal (vice principal, personal communication, 7 Nov 2016), but no one from the teaching or afterschool staff actually came.

This workshop mainly focused on two topics, the wishes concerning activities in the future afterschool club and the students' current experience of the spatial environment. The aim was to collect information that would form the groundwork for the development of the spatial design as well as to provide the teachers, pedagogues and school management with insights into the wishes of the students and their actual experiences of the current space and hence create a focus on the space-practice relationship. Again, the teachers were absent from the workshop, which was found to contribute to the failed alignment.

The content of the workshops

The set-up for the workshops was quite similar as both consisted of three activities. In the staff workshop, the participants worked with future visions, values and a transition ritual, respectively. In the first activity, the assignment was to come up with as many ideas for functions and activities in the space as possible, write them on post-it notes and compile them into categories. In the second activity, the participants were divided into two groups and told to discuss the values of the school: safety, respect and motivation, and how these were expressed in both the physical environment and in the procedures of the school. To visualise the results of this discussion, they had to choose a picture for each value from a set of random picture cards. Finally, the last activity was, while working in pairs, to come up with the wildest, craziest, funniest and best ritual to mark the transition from school to afterschool club.

In the student workshop, the first and last activities were identical to the first and last activities in the staff workshop. Only the second activity differed, as the students worked with the experience of the actual space rather than school values. The students were told to place post-it notes on places in the learning space where they felt safe and liked to work or stay as well as places they disliked. The reason behind the feelings had to be explained on the post-it notes. The aim of this assignment was to start a discussion and an awareness of the physical qualities of the current space that would 'talk back' to the project by providing insights for the design development and research project as well as make the users more aware of their surroundings.

The assignments in the workshops were meant to feed back into the design project by providing the designers with a groundwork for the design development, but were also supposed to create environmental awareness and ownership in relation to the upcoming learning space design. However, the latter did not happen as the teachers were absent from the workshops, which again points to a connection between user involvement in the design process and the relationship between space and practice.

Opposite page: Photos from the workshops and the original space at school A
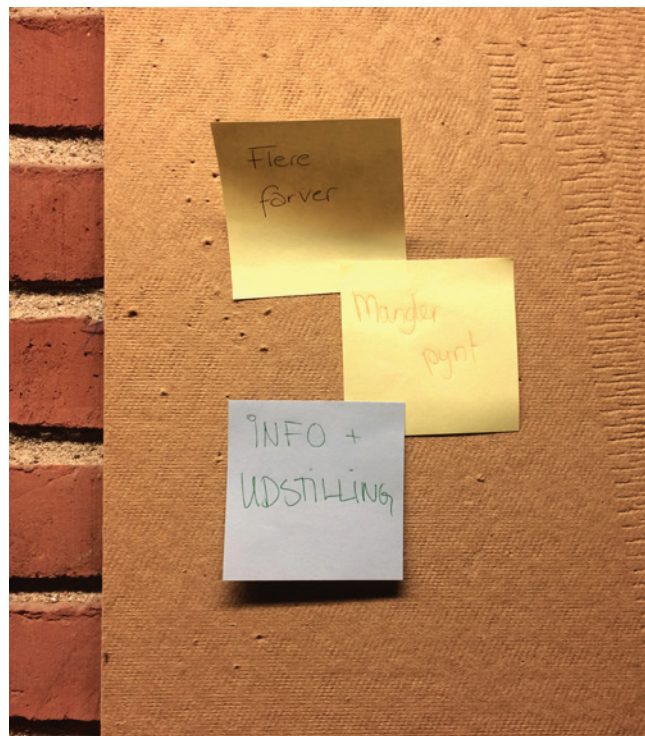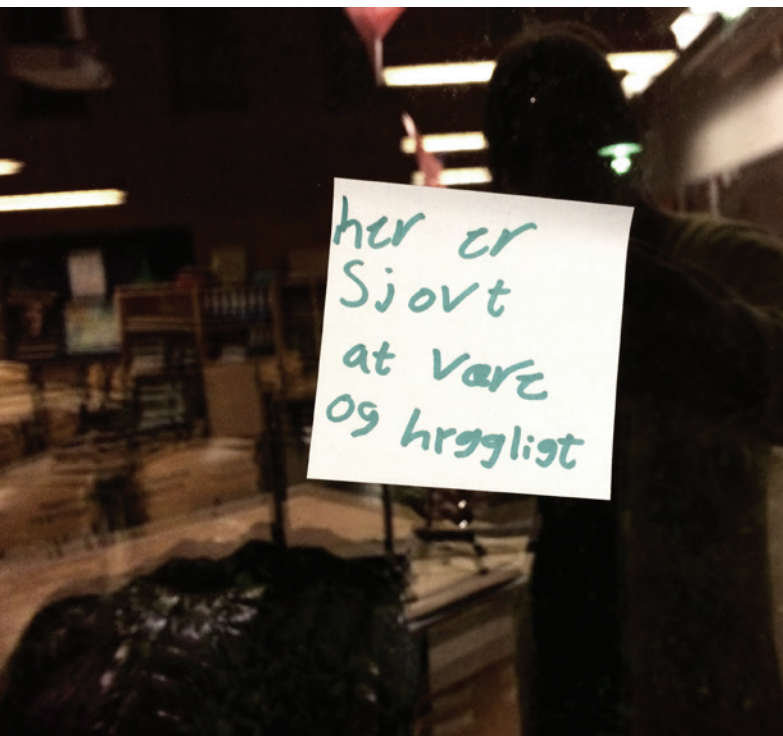
Outcome from the workshops

Initially, the aim of the workshops was to identify current use, future needs and wishes for the new spatial design and the afterschool club as well as to engage the end users in the design process and potentially create an awareness of the spatial possibilities and a feeling of ownership. However, since the teachers did not participate, the spatial awareness of the teachers had no impact and no connection between design intentions and practice was established. Instead, the outcome of the workshops was mainly information provided by the school management and students that could feed into the design project in regard to the current use and future wishes. The findings from the workshops indicate that participatory processes in the design of learning spaces are complicated and depend on many factors, i.e. a strong organisation to secure the involvement of the users in the process. Moreover, it indicates that teacher involvement in the design process affects the alignment of space and practice: The absence of the teachers in the workshops hindered a collaboration between designer and user and made it difficult for the teachers to inform the spatial design and difficult for the designers to influence the use.

Other stakeholder involvement in the design process

The lack of teacher participation in the workshops shows a gap between the intended stakeholder involvement in the design process and the actual involvement. The design project was under both time pressure and budget limitations, which resulted in the actual involvement being mainly the workshops in the pre-design phase, as described earlier, and meetings with the school management and officials from the municipality. A concept proposal and a design proposal were delivered for feedback to the school management in December 2016 and in January 2017, respectively. Comments were mainly made by the school management and officials from the municipal. According to the vice principal (Vice principal, personal communication, 9 Aug 2017), the teachers were informed about the design plans on several occasions, i.e. during team meetings as well as in newsletters, using the material from Rune Fjord Studio (amongst other things). She further explained that the teachers were urged to comment on the design after the team meetings. These occasions were all internal without representatives

from Rune Fjord Studio. In an email from 10 August 2017, I asked if the teachers had had enough opportunity to comment and influence the design even though we (Rune Fjord Studio) did not have much contact with them. The vice principal replied:

> *They have at least been informed and have had the opportunity to comment - BUT because of the time perspective (that we had such a short deadline) I do not think they have experienced that they have had the opportunity to be involved to the same extent as they were, for example, with the working space (the activity-based teachers' lounge mentioned earlier, my note). (Vice principal, personal communication, 10 August 2017, translation from Danish)*

Once more, this points to a lack of teacher involvement in the actual design process. The teachers were only informed about the design process by the school management with an invitation to comment on the design but had no direct contact with the designers and possibly no actual influence on the design of the space. This type of user involvement is what Arnstein (1969) calls 'tokenism' and implies that the users provide information but do not actually have power to make decisions or influence the final results, in this case the design of the learning space.

The intentions behind the design of the space

As a consequence of the failed teacher participation in the design process, the learning space design was mainly based on information from the school management prior to the design process and information collected during the two workshops. Moreover, regular communication between the school management and the designers were held throughout the project. In addition, ethnographic methods like photomapping and observations were used to obtain information about the actual use of the space. This was partly translated into architectural drawings, as shown in Figure 23a and 23b.

The space was designed as an innovative learning space with a diversity of workstations in order to accommodate as many of the requested functions and activities as possible. Considering that the area was rather limited and the space had to be used by different classes and for various activities at the same time, the

workstations were largely fixated and divided according to noise and activity levels. The intentions were to establish an innovative space that would support an innovative teaching practice, thereby creating an innovative learning environment. According to Mahat et al. (2018), an innovative learning environment can be defined as 'the product of innovative design of space and innovative teaching and learning practices' (p. 8).

Furthermore, the design was inspired by research on creative learning, which we attempted to translate into physical designs. According to researchers in creative learning, e.g. Craft (2005), Cropley (2001) and Tanggaard (2014), pedagogic strategies allowing the students to actively engage in the learning process by experimenting, playing or immersing themselves in a topic of interest over a longer time period promote critical thinking and help develop creative skills. To allow for these activities to take place in the new learning space and accommodate as many needs, wishes and functions from the workshops and meetings with the school management as possible, we sought to design a multifunctional space with different activity zones, flexibility and a diversity in workstations. This was supposed to allow for many types of activities and learning styles as opposed to the original interior consisting only of groups of chairs and tables (see Figure 24a and 24b).

The interior design mainly consisted of purpose-built furniture designed to support the needs and visions of this particular school. Furthermore, four pieces of flexible and transformable cabinets were designed to serve different needs. Two of these cabinets were designed as potential tools in creative processes, one as a mobile design studio (The Studio) and the other as a tool for presentation and exploration (The Wunderkammer), both pictured in Figure 25. In the remaining part of the thesis they are called co-creation cabinets. These cabinets became the drivers of experiment #3 in which they were reproduced and explored in school B. This is then compared to the use of the cabinets in school A. The other two cabinets were designed to contain a media centre and a movable theatre (including wardrobe, make-up mirror and stage curtain), respectively.

FLOW DIAGRAM   8 - 10.15 am

	Break	9.50 - everyone in 10.15 - everyone out
	To the sports hall	
	Students arriving	8 - 8.15
	An entire class	8.30 - ud 8.30 - ind
	An entire class	8.55 - ud 9.15 - ind
●	Few persons in the hall 8.20 - 10.20	
●	Water station	
	4 persons	8.25 - 9.10
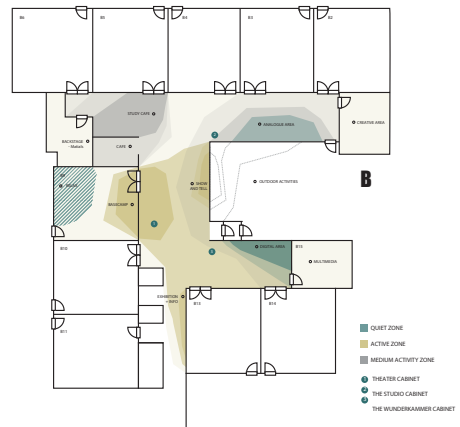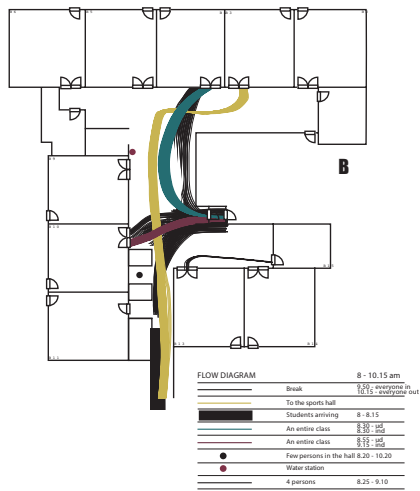
Figure 23a and 23b. Architectural drawings showing flow and zone division, respectively.

Inventory Explanation

- Table
- Table
- Table
- Chair
- Cupboard
- Table
- Shelves
- Bench

Figure 24a and 24b. Floorplans showing the original interior and the new interior, respectively.
See Appendix 3 for larger versions.

Figure 25, The Studio (in front) and The Wunderkammer (in the back) at school A

The new interior in the learning space was supposed to support a change in practice by providing a differentiated learning space. Jamieson et al. (2005) explain how spaces outside the classroom become learning spaces in their own rights when they are designed for different layers of learning (Bøjer, 2017). When designed as a layered environment with different functions or workstations, these new spaces can provide opportunities for promoting individual, one-on-one, small-group and large-group activities which, in turn, let the student take on a more active role in the learning process. I would even argue that learning spaces outside the classroom tend to be less constrained by the educational traditions and habits that often reign in the classroom (Bøjer, 2017), which makes these spaces suitable for a more innovative teaching approach. However, as the next section will elaborate, the expected change in practice did not take place in school A.

The actual use of the space

The afterschool club officially opened on 9 May 2017, but the new learning space was taken into use gradually as the interior design was produced and installed. This had to do with the fact that the space was an existing transit area that connected the surrounding nine classrooms with the rest of the school and the outside playground.

Therefore, it could not be closed off during the implementation process.

The new learning space was designed in an active street-space, as defined by Dovey and Fisher (2014). In this typology the classroom still plays a central part in the teaching and learning situations and therefore, I would argue, does not require as much from the teachers in terms of changed pedagogies as working solely in an open-plan learning space would do.

Still, many of the teachers found it difficult to get used to the opportunities and the limitations of the new space at school A. During the implementation process, I received an email from the vice principal, where she briefly touched upon the reception of the new design and her expectations for the transition process and future use. She writes:

> *The kids are ecstatic – a majority of the teachers are the exact opposite. As expected, new frameworks are difficult ;-) I'm convinced it will quieten down over time – and the teachers will also find new ways to work in the area. Right now, I think it has to do with it not being finished, thus there is a lot of noise and turbulence. The seating areas – meaning tables/chairs – are the biggest challenge for the teachers in the teaching period – they simply do not think there are enough seats. (Vice principal, personal communication, 6 April 2017, translation from Danish)*

This email shows that the vice principal, as a representative of the school management, expected the pedagogical practices to change with the space if the teachers were just given the time to adjust to the new interior. However, as research shows, space does not automatically change practice (Imms & Byers, 2017; Mulcahy et al., 2015), which this experiment substantiated. A couple of weeks after the official opening, I received another email from the vice principal:

> *...a talk about opportunities would be nice – we are experiencing some challenges that we try to handle along the way... and it is now primarily things like e.g. how to use the cabinets [...] (the co-creation cabinets, my note) [...], the change-over between 2 and 3 pm., common agreements about rules in the area. And then we need the school segment to occupy the base during school hours so they get the feeling that it is a common base... this might remove some of the frustrations of feeling "like guests in*

Photos from the new ILE at school A

the area" (as the teachers express it..). (Vice principal, personal communication, 25
May 2017, translation from Danish)

This email was a reply to me, because I had suggested a meeting to discuss an activation process with the teachers in the new space. The reason for this was that I anticipated a complicated process of transitioning into the new space, which I note multiple times in the logbook, e.g.:

I'm worried whether the teachers will be able to accept the new interior and use it
as intended. So, I've thought about whether we should schedule a set of workshops
or a sort of manual that will activate the pop-up furniture (now called co-creation
cabinets, my note) and stimulate creative processes? (Bodil Bøjer, logbook, translation
from Danish, March 2017)

The emails from the vice principal supports the assumption that the transition into new learning spaces is challenging. In this case, there were several issues relating to both practice, space and organisation, as stated in the emails, including the use of the co-creation cabinets, how to switch between school hours and the afterschool club and a common working culture. The email also indicates a twist between the teachers and pedagogues concerning the use of the space, as the teachers felt a lack of ownership of the new space—they felt 'like guests in the area'.

During my research, I experienced these challenges several times. The first indication appeared already during the implementation of the new design, when my colleague and I visited the school to see how the installation was progressing (5 April 2017). As Figure 26 shows, a lot of the purpose-built design was already in place and ready for use, including a high table and high stools. Still, I experienced how a teacher refused to use the high table and stools right next to her classroom. Instead she pulled a small cabinet on wheels and two chairs out from her classroom and placed them in front of the door on a spot where there had formerly been a table and chairs—right next to the high table and stools. There she had several conversations with students before moving everything back into the classroom. This example suggests that change is difficult.

Figure 26. A photo of the space during the implementation process

After implementation of the new design, I returned to the school on several occasions to observe the use of the space and communicate with the school management or teachers. The first time was in June 2017, where Rune Fjord and I held a meeting with the school management to discuss the reception of the new space. During this meeting, the school management told us about the challenges in transitioning into the new space, i.e. establishing rules and frameworks for use during school hours and club hours, as well as activation of the new furniture, especially the co-creation cabinets (personal communication, 13 June 2017). To meet some of the challenges, it was agreed that Rune Fjord and I should participate in the next staff meeting with all the teachers and a pedagogue from the department (August 2017).

In August 2017, three months after the implementation, I returned again to observe the use of the space to collect research data and to participate in the staff meeting. During my observations, I experienced a wide variation in how much the space was

used by the different classes. One teacher seemed to take advantage of the variety of workstations by allowing the students to work in a dynamic flow between the classroom and the new space, whereas most of the other classes stayed inside their classrooms for the whole day or used the new space more sporadically. The co-creation cabinets were not in use.

By the end of the school day I joined the teaching team for their monthly departmental meeting (meeting summary in Danish, 24 Aug 2017). Two weeks prior to the meeting I had communicated with the vice principal and she had asked us to address and activate the space in relation to practice at this meeting:

> It would be good to talk about the use of the facilities during school hours—meaning the possibilities with the wagons (cabinets, my note) in particular. Could we, for example, make some "tasks" that involve the use so that it can be experienced in practice? In addition, they may have to be "challenged" a little bit on the use of the department, cf. the things we discussed earlier this year. (Vice principal, personal communication, 25 May 2017, translation from Danish)

We agreed to set up a 30-minute workshop as this was the maximum time the teachers could devote to this issue, according to the vice principal. The 30 minutes included a short presentation about the original intentions behind the design and a brief discussion about the use of the area relating to three questions: What were the challenges related to the new space? What was good about the new space? And what could be even better?

The answers mainly focused on the following topics: acoustics, spatial setting and use. Several teachers complained about the acoustics and found the space noisy with so many students and activities taking place simultaneously. They thought there were too few tables when the space was used by many students simultaneously (there are actually more seating arrangements now than before the refurbishment, but they do not all include tables). Someone also pointed out that it was hard to make use of the good elements as it demanded readjustments by the teachers. Still, it was not all negative responses. One teacher told us that he was not bothered by the noise but thought the space worked really well and suggested that the experience of the space

depended on the individual.

During this meeting, I even discovered that not only were many teachers unaware of the intentions behind the design of the learning space; they did not know that they were allowed to use the co-creation cabinets and had no keys to unlock them—literally. The only set of keys was managed by one of the pedagogues, and this person was only present during the afterschool club hours.

The responses by the teachers and the dilemmas of use highlighted some of the issues surrounding the design of new learning spaces and user participation in the design process. As one teacher pointed out, the teachers had to readjust their practices to be able to actually use the design. Since they did not participate in the design process, they did not know the intentions behind the design and had no sense of ownership of the space, nor did they receive any training in how to use the spaces, which made it difficult to change practice. And conversely, the space was not at all adjusted to their current or envisioned practices. During the meeting we suggested that they should begin talking about the space during each upcoming staff meeting in order to start a common culture regarding the use of the space. However, this was not implemented until a year later when the school management requested it to be a regular point on the staff meeting agenda (Teacher C, personal communication, 15 March 2019).

Three months later (Nov., 2017) I revisited the school to observe the use of the space in order to see if practice had changed but found everything to be status quo. Very little had changed in terms of pedagogical practices and the co-creation cabinets were still unused. I already knew in advance that nothing major had been done to activate the co-creation cabinets as I had been emailing with the vice principal about the topic in both September and October 2017. No materials or tools for creative processes had been placed in The Studio cabinet, which partially explains the lack of use. The Wunderkammer cabinet was likewise unused, which points to a reason beyond the missing tools and materials and suggests a need for activation.

Then, when revisiting the school one year after the opening (May, 2018) to meet with a 4th grade teacher (Teacher C) concerning an activation workshop (which was never implemented), I experienced a setback. Before redesigning the space, the teachers had fixed rules regarding the number of students from each class to let out into the space

and which spatial settings they were allowed to use. These rules were now back in use, as explained by Teacher C (personal communication, 3 May 2018). This meant that the space was being used according to a teacher-made division and teacher needs rather than letting the activity and the affordance of the space or learner needs guide the use. The co-creation cabinets were still unused.

According to Lackney (2008), this retreat into old practices can be seen as a result of the teachers not being trained in how to utilise the affordances of the space, thus making them return to the safety of their default practice (Cited in: Byers et al., 2014). This corresponds well with the statement by the teacher at the staff meeting about it being hard to make use of the good elements as it demanded readjustments (of practice) by the teachers.

The risk of participatory processes

The anticipated alignment of organisation, learning space and pedagogical practices did not take place during the design process of the new space as displayed in the previous sections of this chapter. As explained in chapter 3, according to Blackmore et al. (2011), there is a rise in research emphasising the importance of user involvement in the process of change in a school. Könings et al. (2017), for instance, explain participation in the design of learning environments as a means to account for the different expectations and perceptions of stakeholders, but also notes that contrasting expertise, cultures and priorities might limit the actual results of the participatory process. This poses a challenge to the alignment of spatial design and pedagogical practices.

As experiment #1 demonstrates, participatory design processes can be complicated and difficult to conduct. In line with the reflections by Könings et al. (2017), Nordquist and Watter (2017) explain that the different 'universes' (backgrounds, agendas, cultures, etc.) of the stakeholders also means that they speak different professional languages (language here refers to the technical languages and understandings, i.e. in a building process, and not geographic languages), which makes communication difficult. For this reason, educational input risks getting 'lost-in-translation', as Nordquist and Watter (2017) put it. Again, this causes a risk to the alignment of space and practice. Moreover,

external factors also influence the participatory design process. The involvement of the stakeholders in the design process of new learning spaces might be limited by time schedules, budgets, the size of the school etc., as concluded by Parnell et al. (2008).
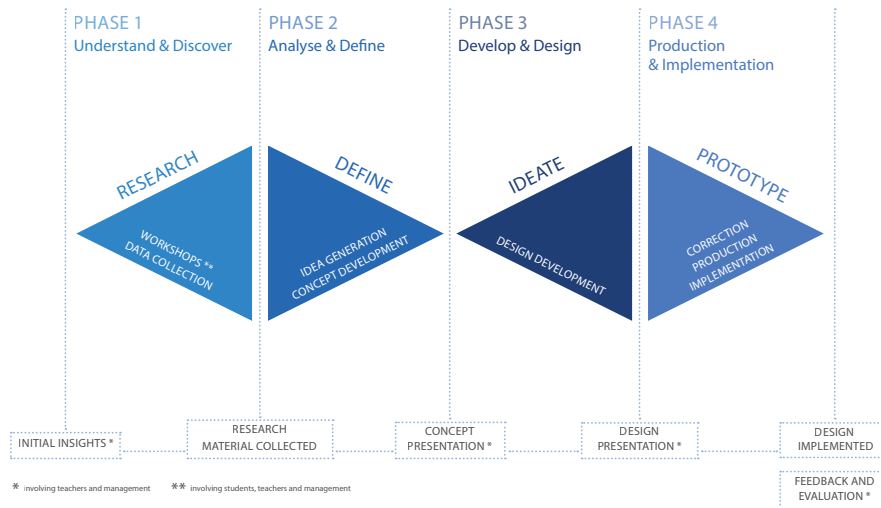
Figure 27. The design process with user involvement included

As visualised in the design process model, Figure 27, the teachers were meant to take on a more active role in the process of designing the learning space at school A. However, this did not happen. I reflect on this dilemma in the book chapter based on the paper for the Transitions conference in London 2017:

> *In retrospect, more effort should have been made to involve the teachers in the design process in order to make the proposed alignment [...] and create a common vision. School management was easily engaged in the process, presumably because they were the contracting authority, but it was difficult to engage the teachers, which resulted in very limited direct communication between teachers and designers. The exact reasons for this are unknown, but prospectively it is a challenge to secure the involvement of all parties during the design process. The teachers' experience of the space as being difficult to match with their usual way of teaching indicates that the intended alignment between teaching, organisation and space did not happen during*

the design process. Except one, the teachers were neither directly nor indirectly involved in the design process, resulting in a mismatch between design intentions and pedagogical practices, limited awareness of the intentions of the space, and a lack of ownership for the new design. With the proviso, that any transition from one teaching method to another may be complicated, I suggest that greater involvement in the design process could make this transition easier and secure that design and pedagogies correspond. Jamieson et al. (2005) stress the importance of bringing together the key stakeholders during the design process, which demands a visionary strategy for the project prior to the design phase to establish a common language and an overall understanding of the teaching strategy and different learning activities. Furthermore, they claim that the teachers should be guided into using the new types of learning spaces, which is backed up by Lackney (2008). Similarly, Blackmore et al. (2011) emphasise that new built spaces will not move teachers to innovative pedagogies unless they are prepared and provided with the necessary skills, tools and resources to change their practices. (Bøjer, 2019, in print)

As I claim in the quote, the mismatch between the new learning space and pedagogical practice at school A is partly due to failed user involvement in the design process. If the teachers had participated, they would have had the opportunity to affect the design and there would have been a better chance of creating ownership and alignment between space and practice. Still, even if we had managed to engage the teachers in the design process, this would not necessarily have secured the alignment of space and practice. Both Blackmore et al. (2011) and Lackney (2008) emphasise that teacher training is necessary in order to change practices. This was even my experience in the first experiment.

Building new learning spaces is a participatory process

In early 2019, I contacted Teacher C again to get an update on the use of the learning space. She initially wrote back to me that they no longer split the space between the classes so everyone could sit wherever there was a free seat. Only a few areas were reserved for a class with children with special needs. When I asked her to elaborate on the change, she answered:

XXX (the Vice principal) and I held a meeting before the summer holidays where we made some decisions about the space. I also got some lessons to 'follow up' on. We decided, amongst other things, that the blue furniture should not be moved and that the cabinets should be moved out of SFO2's room (the afterschool club space, my note). It is difficult to change practice as we are many users of the space and communication doesn't always reach all users. We try to keep the lines of communication in that the management issues guidelines and we talk about them jointly at the staff meetings. I still experience that people haven't taken proper ownership of the space. We still try not to send too many students into the common space. (Teacher C, personal communication, 15 March 2019, translation from Danish)

At the end of the correspondence she once more emphasises the challenges in aligning space and practice:

I want to say that I still don't think the room is fully used. I [...] don't feel that the task can be lifted by a single employee. Next year I will change department and then nothing more will happen [...] There ought to be hours allocated and a real effort should be agreed upon if you want to take advantage of the resources offered by the space. (Teacher C, personal communication, 15 March 2019, translation from Danish)

Gislason (2018) emphasises this necessity of allocating funds and effort. He claims that it is essential to have organisational support, including time and funds for curriculum development and staff training, when establishing unconventional programs in schools. Otherwise it is likely to fail.

As explained earlier, the spatial design of the new space was intended for a more innovative teaching approach, which demands a change in pedagogical practice. At first, the school management had expected the change to happen due to the change of space, but instead the teachers retreated into old habits and once more divided the use of the space between the classes. Gislason (2018) claims that, according to historical case studies, without organisational support, the most reasonable approach is to revert back to a traditional classroom layout. As the quotes from the communication with the teacher demonstrate, it was not until school management took control of the space

and set out guidelines for the use that an alignment of space and practice began to occur. This corresponds with Lackney's (2008) observation presented earlier, where he points out that teacher training in environmental competence not only concerns the individual teachers but requires organisational support from the school management.

Presumably, the lack of change can be ascribed (at least partly) to the lack of teacher participation in the design process, which, in turn, alters the balance in the alignment of practice, space and organisation. This corresponds with the view in ANT that the stability and continuity of actors depend on other actors and actions. If the alignment of the three elements is thrown off balance, e.g. with a lack of teacher participation in the design process, the relationship between space and practice might be affected.

The findings from experiment #1 indicate that the relationship between space and practice is affected by the degree of stakeholder participation in the design process, especially when it comes to the teachers. I will therefore argue that it is highly significant to involve the stakeholders in the design process in order to create alignment between learning space and pedagogical practice. According to Clark (2010), the involvement of the users in the design process tends to improve the understanding of needs, resulting in a more suitable building (cited in: Könings et al., 2017).

Teachers, designers and school management are stakeholders with potentially very different backgrounds and professions and do not necessarily have in-depth knowledge about each other's professions. The participatory design process has the potential to become the arena, where the professions meet to create a common language and a framework for the design of a new learning environment where space and practice correlate. As pointed out by Jamieson et al. (2005), creating a common language and an overall understanding of teaching strategies and learning activities is vital in order for key stakeholders to be able to work together in the design process of new learning environments. According to Gislason (2018), this is a long-term process, in particular when it comes to innovative learning environments, which he claims takes (preferably) 2-3 years to plan in order to match design and pedagogical practices. Otherwise, Gislason (2018) claims, the teachers will have to divide their energies between teaching, developing curriculum and adapting to an unfamiliar setting. This claim is backed up by Parnell et al. (2008), whose findings suggest that efforts to ensure

active participation by the school communities should commence well in advance of the 'live' design process. However, in reality this time span is rarely present, at least not in minor building projects. This is why stakeholder participation in the design process becomes so crucial, because it allows for the teachers, designers and school management to develop the new learning environment collaboratively and thereby, at least partially, match practice, design and organisation.

The findings from experiment #1 also indicate that participatory processes are complicated by the many external factors influencing the degree of stakeholder involvement. This corresponds well with current research in participatory building design by i.e. Könings et al. (2014) and Woolner (2010), as discussed previously. In this case, the budget and a tight time schedule were amongst the factors restricting the participation of the teachers in the design process. Another factor might have been the belief of the organisation that the space would transform practice over time, which meant that they did not ensure the participation of the teachers in the process. Beghetto & Kaufman (2014) point out that leadership plays a key role in establishing an environment supportive of creativity, which I would argue applies to any kind of new pedagogical practice. Because, as stated earlier, just changing the physical settings does not guarantee a change in pedagogical practice. As Burke (2016) argues, the intentions of a space can only be fully realised if the inhabitants of the school completely understand and support the pedagogical principles informing the provision of the space.

Experiment #1 shows a strong connection between space, practice and organisation, where each element affected the others. In this case, the teachers (practice) did not participate in the design process and the school management (organisation) did not secure the participation or training of the teachers, which in turn affected the use of the final learning space design. When finished, the space in return affected the teaching practice as its spatial affordances required a different approach than the traditional teacher-centric approach most observed in this department. The teachers responded to this by either embracing the new possibilities or, as most of them did, trying to work against the affordances of the space. In relation to ANT, this illustrates how the relationships in networks affect each other and how networks exist in a constant

process of making and re-making. This mutual and interdependent relationship between space, practice and organisation is visualised in the learning environment triangle from before (Figure 7, p.77), but could also be illustrated as a more dynamic process as proposed in Figure 28.
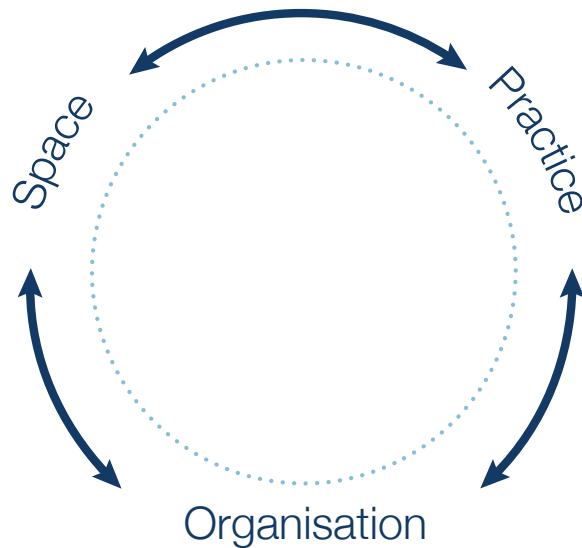
Figure 28. The mutual relationship between space, practice and organisation visualised dynamically

The findings from experiment #1, in combination with current research, has led to the assumption that participatory design of new learning spaces is not always enough to assure the alignment of space and practice. As a response to this, I propose an additional activation phase in the design process after the implementation of the final design. This means that based on experiment #1, the initial program of this research project has drifted to even focus on a post-design process aiming to activate and transition into new spaces. Focus changed from design process to include participatory activation and, as such, the experiment developed the research program and the project.

A delivery and activation phase to support the transition into new spaces

Through practice, school visits and talks with fellow peers, I have experienced how the interaction between creators and users of new learning spaces often ends as soon as the design is implemented. This leaves the users with a spatial design they might not have had a lot of influence on nor the environmental competence to use. The intentions behind a new spatial design can be difficult to decode and unless there is a common vision and strong leadership to push the project forward, the new design risks becoming an obstacle instead of an asset for teachers and students (Bøjer, 2017).

This is also the case in experiment #1. In addition, user participation in the design process turned out to be more complicated than expected, and as it failed, so did the alignment of learning space and pedagogical practice. This indicates that there is an interdependent connection between the involvement of the users in the design process and the final use of the space that needs to be taken into consideration when designing new learning spaces.

Based on the findings from the first experiment and the reflections and assumptions that followed, I propose a fifth phase of delivery and activation as shown in Figure 29. The purpose of this phase is to activate the new space in collaboration with the users and thereby match spatial possibilities with pedagogical practices.
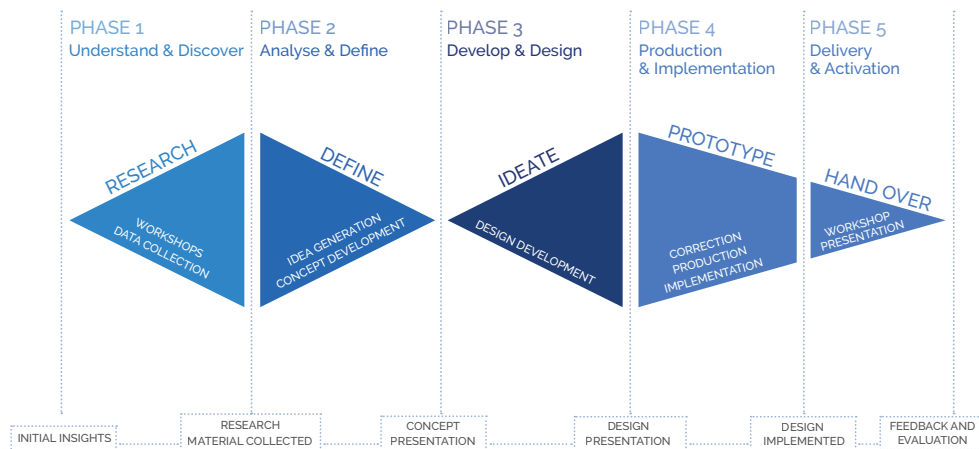
Figure 29. Design process model in five phases, including a delivery and activation phase.

The aim of this phase is to hand over and activate the new learning space in collaboration with the users. This is suggested to take place as a participatory process, where the intentions of the learning space design are translated into actions and negotiated through appropriation with the users (preferably both students and teachers). The aim is not to tell the users how to use the space but to explore the possibilities in a collaborative process in order to develop environmental competence and match design and practice. Blackmore et al. (2011) point out that listening to and working with students and teachers can help transform both learning spaces and pedagogical approaches. According to Higgins et al. (2005), this involvement of students and teachers needs to continue throughout all phases from design to evaluation in order to achieve a sustainable impact within a rapidly changing context. Based on experiment #1, I therefore suggest that the involvement of students and teachers in the activation of learning spaces continues beyond the design process. Reflections on how this could be done have led to experiment #2, where approaches from co-design are explored as tools to inform the relationship between space and practice.

EXPERIMENT #2 / THE DESIGN TOOLS

Experiment #2 was developed based on the findings in the first experiment. In 2017 I had been accepted as a presenter at an international conference in London, Transitions, as mentioned earlier. At the same time, I was digesting the outcome from the first experiment, trying to understand the failed teacher involvement and the change in practice.

My presentation topic for the conference was my research project and experiment #1 in particular. During the process of writing the paper for the conference as well as through discussions with fellow peers at the conference, the insights concerning the complications with participatory design processes of learning spaces and the need for further activation after the implementation of the design evolved. I realised that the design process in many cases ends too soon and thus the idea for experiment #2 was born.

The second experiment took place in school B in 2018. The experiment examined how approaches from co-design can be used to enhance environmental awareness and competence in teachers and thereby positively inform the interplay between learning space and pedagogical practice—both during design processes and in a subsequent activation phase. The aim was to explore the potential of co-design as a tool to activate learning space designs in appropriation with the users.

Hence, the research question framing this experiment is: *How can approaches from co-design inform the interplay between pedagogical practices and learning space design and the transition into new learning spaces?*

Co-design tools and techniques played the central role in the experiment. The co-design approach was selected because of its active involvement of the participants in the design activities and its potential to initiate a discussion about abstract pedagogical philosophical issues like the experience and use of a learning space through a very concrete subject—the layout of the space. Könings, Bovill and Woolner (2017) suggest facilitation and visual activities as a means to engage participants and encourage the sharing of ideas in participatory building design. The participants, in this case teachers and students, were included in the design activities as experts on their own teaching

and learning. The intention of the experiment was to examine whether different co-design activities would provide the teachers with more insight into the needs and experiences of the students in relation to the interplay between learning activities and space and, as a result, enhance their environmental awareness and competence.

Returning to the design process model presented earlier (Figure 29) the activities in experiment #2 were imagined to take place in the fifth 'Delivery & Activation' phase of the process. I use the word 'imagined' as the actual experiment did not in reality succeed a design process—at least not directly. The school in which the experiment took place had been renovated two years earlier, but Rune Fjord Studio and I had not been involved, nor did we have any knowledge about the renovation process and the intentions of the new learning space designs. This, however, was not found to be a hindrance to the experiment. In both constructive design research and co-design focus often is on the imaginary as the designers—and in co-design even the co-designers—work with visions and ideas for the future. In constructive design research, researchers imagine and build new realities (e.g. scenarios or detailed concepts) to see if they work and subsequently these constructions are analysed (Koskinen et al., 2011). In experiment #2, we imagined and 'built' a co-design process to explore co-design and participatory activation as a means to inform the relationship between space and practice.

As proposed in constructive design research, the constructions once more took centre stage in this experiment and were used as a key to constructing knowledge. In experiment #2, the constructions consisted in particular of a co-design process with three co-design workshops and a variety of co-design tools and toolkits that were used to explore current conditions and future perspectives in learning space design. These were subsequently framed by and explored against the program and overall challenge in the programmatic framework as defined in chapter 4.

Structure of the experiment

Time frame, participants & location

School B was located in central Copenhagen in several old multi-storey buildings and renovated in 2016 for 180 million DKK (principal, personal communication, 20 Aug 2018). The students were divided into classes according to age with approximately 24 students per class, which is very common in Denmark. Each class had its dedicated classroom with 24 chairs and matching tables.

The principal of the school was the former principal of school A, who transferred from school A to school B in the beginning of experiment #1. In the fall of 2017, Rune Fjord contacted him to offer the school to test the co-creation cabinets and participate in a couple of workshops concerning space and practice (free of charge). In December 2017, Rune met with him (I was unfortunately ill) and two teachers to explain the details. The teachers agreed to participate, and a second meeting took place in early March 2018 to plan the last details. Based on the experience from experiment #1, we were very conscious about involving both the teachers and the school management before starting up the process to make sure that both would support the project.

The experiment started in March 2018. For three months, teacher T (subjects Danish and Arts) and teacher F (subject Math) and their fifth grade (24 students, 11-12 years old) participated in experiment #2. During this period, the class and the teachers took part in three co-design workshops of 2-4 hours' duration at the school and worked independently with their learning space and a set of co-creation cabinets, The Studio and The Wunderkammer, in between workshops (see Figure 30). These prototypes served as tools in the workshops and in the educational activities in between the workshops. Both prototypes were refined from the first edition at school A and produced by Højer Møbler. Apart from the two co-creation cabinets, the spatial design in the learning environment was the same as before the project.

The experiment took place at the school during regular school hours in the regular classroom and an adjacent flexible learning space that the class shared with two other fifth grade classes. The adjacent learning space was only used sporadically and the interior layout consisted of an old worn-out sofa and arbitrary pieces of furniture as

well as storage for computers (for all three classes). As explained earlier, experiment #2 was initiated as an activation activity imagined to take place in the fifth phase of the design process model in Figure 29. As school B was already renovated 2 years earlier, the experiment did not directly succeed a redesign process; however, this was not considered important for the research project.
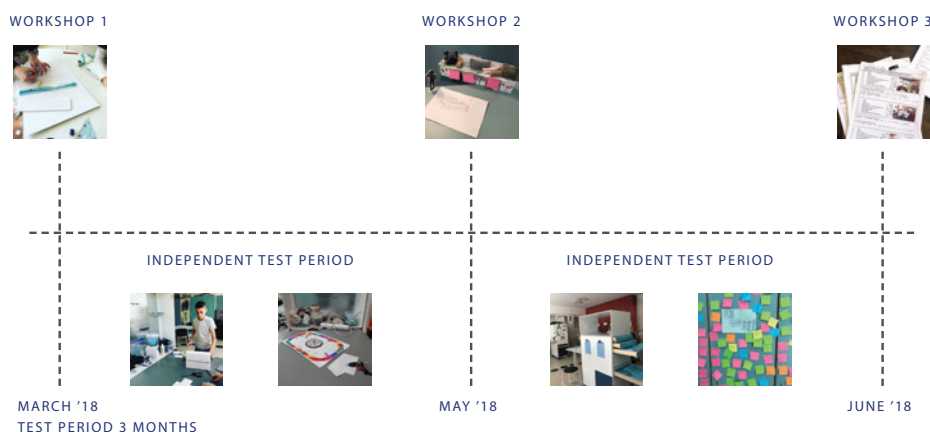
Figure 30. Overview of the co-design process in experiment #2

Workshops and activities performed during the experiment

Three workshops took place during the experiment: an initiating workshop, #1 (20 March 2018, at 8 am. –– 11.40 am. Facilitators: Rune Fjord and Bodil Bøjer), a mid-way workshop, #2 (15 May 2018, at 8.20 am. –11.40 am. Facilitators: Rune Fjord and Bodil Bøjer) and an evaluation workshop, #3 (25 June 2018, at 8.20 am. – 10.00 am. Facilitator: Bodil Bøjer). Each workshop consisted of a series of activities where co-design tools and techniques were explored as a means to create greater awareness about the experience and affordances of the physical learning space in relation to pedagogical practices.

In between the workshops, the teachers tested the prototypes as part of their pedagogical practices and documented these activities with photos and small descriptions on Instagram in a project account called 'Unlocking Learning Spaces'. This process was entirely up to the teachers, who independently came up with, planned and ran the activities.

Documentation setup and data analysis

The methods used to collect data consisted of a mix of co-design tools (mainly toolkits and workshops) and ethnographic methods (e.g. photo documentation, observation and interviews). During the process I kept a logbook and documented the workshops using film and photography as well. Reflections were done both in and on action and through discussions with my colleagues at Rune Fjord Studio as well as the teachers and the students at school B. Moreover, two semi-structured interviews (of approx. one hour's duration each) were held with the teachers after the experiment (Teacher 1, 25 June 2018, Teacher 2, 2 July 2018) and each student answered a questionnaire during the last workshop. The teachers documented their work occasionally in between the workshops on the Instagram account, set up for this research project. Furthermore, I conducted participant observation (Szulevicz, 2015), both during the three workshops and additionally on a separate day (20 June 2018).

The semi-structured interviews were transcribed using a simple transcription strategy, where focus lay on maintaining the essence of the content (Tanggaard & Brinkmann, 2015a, p. 43). This was then coded and dissected using concepts extracted from existing literature and the learning environment triangle: space, practice, organisation and in addition, co-design. Subsequently, these were divided into sub-themes (listed below) in order to be able to separate the answers by the teachers into different themes relating to either one element alone or the relationship between two or more elements. The subthemes are also used to separate findings relating to the two experiments, #2 and #3. Whereas the two experiments are treated as two separate experiments in this thesis, in reality they were intertwined and took place simultaneously and were, as such, not considered individually by the teachers. Therefore, they talk about both the process and the cabinets intertwined in the interviews. The subthemes were colour-coded in the transcripts (Appendix 4) and each section relating to an element was filed into an Excel diagram in order to create an overview of the material (Appendix 5):

- Space + affordances (the physical space and its actual spatial qualities)
- Practice (pedagogical practice)
- Space – practice relationship (the interplay between space and practice)

- Prototypes / affordance + practice (the co-creation cabinet prototypes, how their design affect practice)
- Prototypes / commitment (how the commitment to use the prototypes affect practice)
- Workshops + practice (how the workshops affect practice)
- Workshops + prototypes (the relationship between these two and the way this influences practice)
- Organisation (the organisation at the school, e.g. time, organisation of space etc.)

Subsequently, the interviews have been re-examined together with the colour-coded interviews. Part of the analytical process was conducted by simply writing about the experiments in this thesis, as recommended by Tanggaard and Brinkmann (2015a), who emphasise that writing is an analytical tool in itself.

The main data stems from my observations and reflections-in-action during the workshops as well as the semi-structured interviews with the teachers following the entire process. Again, the learning environment triangle acted as an analytical lens through which I have examined the collected data, searching for findings related to the three themes—practice, space and organisation—and the connections between these as well as their relationship to the overall challenge and the program. In addition, I have also searched for findings more directly associated with the co-design approach (activities and materials). I have tried to keep an open mind while reading the material but I have also read it theoretically as I have noted and related findings to other studies and literature. Continuously in this chapter, the findings are understood and explained in relation to the elements of the triangle and to current research.

The respondents were chosen for the experiment based on mainly practical reasons: The school was located in the same city as our office and we already knew the principal from another project, which made the contact easier in the proposal phase. Based on my insights from the first experiment, I contacted the principal of school B and suggested the co-design process and co-creation cabinets, which he accepted. Subsequently, he proposed the idea to the teachers and set up a meeting with them, Rune Fjord and me.

Design tools used in the workshops

According to Sanders et al. (2010), each participatory project is unique and demands its own specifically chosen approaches, methods, tools and techniques. Therefore, each new project requires a strategically designed toolkit and method aimed to serve the specific purpose of this participatory project. The toolkit is explained by Sanders et al. (2010) as 'a collection of tools that are used in combination to serve a specific purpose', whereas the method is 'a combination of tools, toolkits, techniques and/or games that are strategically put together to address defined goals within the research plan' (p. 4). Furthermore, they emphasize the importance of considering the entire experience that the participants are going to go through and make each activity lead to the next when designing the method.

Therefore, the total experience was an important aspect when designing the three workshops in experiment #2, both from a theoretical perspective but also based on the experiences from experiment #1. According to Lundsgaard (2011), users and other stakeholders are often involved in a series of workshops in a co-design project, where different tools and techniques are used to inspire the participants to experiment and explore possible solutions by creating common tangible outputs. Inspired by Sanders et al. (2010), Brandt et al. (2012) as well as Sanders and Stappers (2014) we worked with different co-design tools and techniques in each workshop and collected these in toolkits developed specifically for this project in order to engage the participants. The toolkits were supposed to help create discussions and reflections on space and practice and through this potentially contribute to activating space in relation to practice. From an ANT-perspective, they were assigned the role as actors who were to make others act. Furthermore, they worked as means to constructing knowledge as proposed in constructive design research.

In experiment #2, we attempted to combine different types of toolboxes, making, telling and enacting, respectively, because, according to Sanders et al. (2010), the co-design tools and techniques are best used in combination in a workshop or research plan, where all three types of toolboxes are used. The toolkit for each workshop will be explained further in connection with the section describing the workshop in question. All three workshops were held with the same teachers and students in the same spaces.

The co-design workshops

The co-design workshop is the main participatory method used in experiment #2. During these workshops, the students and teachers were guided into thinking about and discussing their actual learning space and learning activities, which then led to imaginations of future learning spaces. The intention was to examine, whether co-design activities would provide the teachers with more insight into the needs and experiences of the students in relation to the interplay between learning activities and space and thereby stimulate and enhance environmental awareness and competence. Therefore, the activities were addressing issues like: How do students experience their surroundings, and how do they see their own needs in relation to different learning activities?

The workshops were planned as a set of activities where each succeeded the other to add up to the total experience. Furthermore, the workshops kick-started, continued and concluded the three-month process of the experiment, thereby addressing different issues relating to the learning space and pedagogical practices. The students were the active participants, whereas the teachers remained in their 'teaching role', strolling from group to group during the activities.

In the first two workshops, the students were engaged in a number of co-design telling and making activities, which I will explain in more detail in the following sections. The third workshop did not include any co-design activities (only a questionnaire and a form) as focus was on evaluating the process and collecting data for the research project. Time was also more limited in this workshop. In retrospect, the third workshop would probably have benefited from a co-design approach as it turned out to be difficult to engage the students in this workshop. This was not the case in the first two co-design workshops.

The activities were planned in a way that was meant to build up to an increased reflection about the interplay between the physical design of the learning space and the pedagogical practices and learning activities. Overall, the activities moved from being sensuous and non-reflective to imaginations of future learning spaces and

Photos from workshop #1 (opposite page).
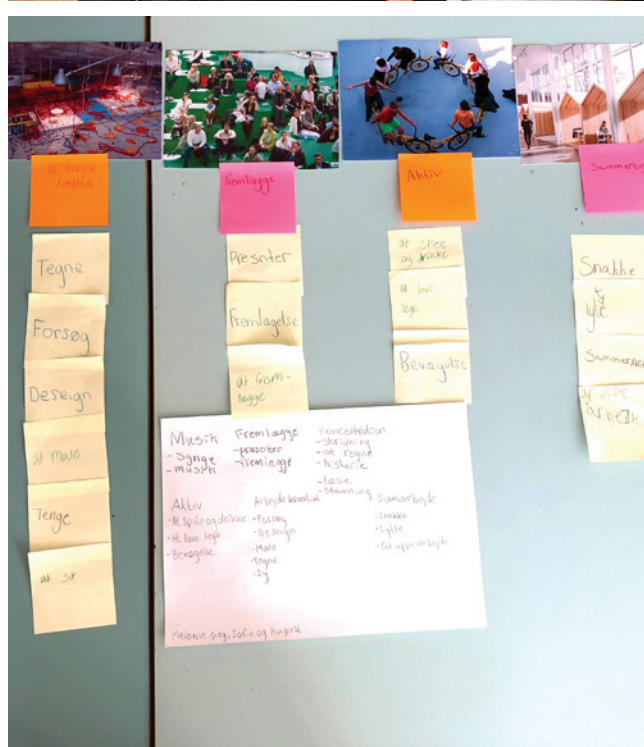
furniture and ending up with an evaluation and a collection of knowledge. The aim was to create a complete experience, where we started in the present in workshop 1 (the actual sensation and qualities of the space), moved on to the future in workshops #1 and #2 (future learning spaces and furniture) and returned to the present in workshop #3 (what have we learned?). This framework was intended to explore the potential of co-design as a tool to inform the interplay between the learning space and pedagogical practices.

In the first two workshops, the students were reflecting on their actual surroundings while using them in a new and flexible manner. We altered the spatial setting for each workshop and opened up to the adjoining learning space to break with habits and give the students multiple working stations to choose from. The reason was that we wanted them to physically experience how the space could support different learning situations and not just discuss it. At the same time, we wanted to show the teachers how the students would use the space when given a free choice. As anticipated, many students chose to use the space in a more flexible manner by sitting on the windowsill, in the sofa, at a round table or in the hallway instead of at their regular tables. In the final workshop, the learning space setting was kept as usual and the students were working at their regular desks.

The initiating workshop #1

The purpose of the first workshop was to kick-start the process and to lead the participants into exploring the physical learning environment by using approaches from co-design and thereby, potentially, obtain greater environmental awareness in relation to their pedagogical practices (teachers) and learning activities (students).

As explained in the previous section, the workshops were planned in a way that was meant to build up to an increased reflection about learning spaces and learning activities. In the first workshop, the focus was on the sensation of the actual space, the range of learning activities and the adequate functions in a learning space to support the learning activities. We did not know the level of reflection and knowledge in neither students nor teachers regarding the relationship between space and practice; therefore we wanted the activities to build up a natural foundation and successive

knowledge through active exploration and reflections on space and practice. This workshop was also the most comprehensive of the three with the most widespread activities, as we went from working sensuously and non-reflectively to reflecting on different types of learning activities and building models of imaginative learning spaces.

The generative toolkits in workshop #1

During the workshop the students went through four activities based on telling or making approaches, where they worked with generative toolkits. As explained in the previous chapter, the generative toolkit is often used in co-design activities to help non-designers imagine and express their own ideas about the way they want to live, work and play in the future (Brandt et al., 2012; Sanders & Stappers, 2008). The generative toolkit consists of a variety of co-design tools and has the potential to evoke thoughts and feelings that the participants do not normally talk about (Brandt et al., 2012).

The participants were working in four groups with six students in each. An overview of the co-design activities in the first workshop is provided here and will be explained in detail in the following sections on each individual activity:

1. Reboot: Intuitive drawing to music and sound;
2. Space-dotting: Placing hearts and fire stickers on things the participants liked or disliked in the learning space;
3. What activities should you be able to do in a learning space: Listing and categorising learning activities and matching them with pictures of a more or less abstract character;
4. Build your dream learning space: Building models of imaginative learning spaces.

Each activity was accompanied by a generative toolkit (Sanders et al., 2010a) that was meant to help the participants discuss and imagine learning space designs now and in the future.

1. Reboot: A long piece of paper from a paper roll, multiple coloured pens, music and sound;
2. Space-dotting: Post-it notes, pens, two stickers per participant of which one was a

heart and the other a fire;

3. What activities should you be able to do in a learning space: Post-it notes, pens, four sets of picture cards;

4. Build your dream learning space: A generative toolkit with a wide range of materials (e.g. paper, pins, straws, cardboard, paperclips, textiles, pompoms,coloured toothpicks, recycled materials, coloured pens, pencils, glue, glue guns, scissors, staplers, tack-it, and Stanley knifes).

Activities 1-3 were 'telling activities', as defined by Sanders et al. (2010a) and Brandt et al. (2012), aiming to make the participants talk about existing pedagogical practices and future visions for their learning space.

Activity 4 was a 'making activity', as defined by Sanders and Stappers (2014), where the participants discussed and created future scenarios through the act of prototyping their dream learning spaces. Each activity was followed by a common discussion session, where the individual groups presented their reflections and work to the rest of the class.

The co-design activities

Start-up

Prior to the start of the workshop, we altered the setting of the learning space in order for it to become a tool for our exercises and break with expectations and habits. The intention was to make the space become a 'lab' for testing out other learning space designs while working with the co-design activities. Therefore, we changed the traditional setting with groups of chairs and tables into one elongated table in the centre of the room. On top of the table, we placed a long piece of paper to draw on. We even set up smaller workstations around the space.

The very first thing we asked the participants to do was to lie down under the table and listen to music from an opera (Figure 31). The purpose of this pre-exercise was to break with the participants' habitual thinking and expectations for the lesson. At the same time, the intentions were also to make the participants aware of the spatial qualities and the materiality of the spatial setting. By seeing and experiencing the space from a different angle than usual, the participants became more aware of the

environmental qualities of the space, as will be discussed later.

Figure 31. Start-up exercise: Listening to opera

Activity #1: Reboot!

The first 'real' activity continued the exploration of the intuitive sensation of the space. While listening to two very different sounds, the humming of bees and a punk song, the participants were told to draw intuitively with their eyes closed on a roll of paper (Figure 32). They were standing very close around the elongated table, so they could feel each other and the sounds in the space. The intentions were to create a sense of togetherness in the participants as well as to move the focus from the visual sense to the hearing sense and the bodily sensation of the space. The difference in sounds was intended to demonstrate how sounds can be experienced as either pleasant or unpleasant. Afterwards we reflected on the feelings that the activity generated in the participants and the fact that sound plays a large role in how a space is experienced. This was a way to set the stage for the next activity.

Activity #2: Space-dotting

The second activity was directly related to the actual surroundings in the learning space. Each participant received two post-it notes on which there was a heart sticker and a fire sticker, respectively. The assignment was to place the heart post-it note on something (a place or a thing) that they liked in the space and write an explanation. Simultaneously, they had to place the fire post-it note with an explanation on something they did not like. The purpose was to visualise how space is experienced differently and to create an awareness of the affordances of their actual space.

Figure 33. Activity #2: Space-dotting.

Afterwards we talked in plenum about the different choices in order for everyone to get an understanding of the affordances of the space and how they were experienced. The most common likes and dislikes were related to a worn-out sofa and a half-circle shaped table in the adjoining space as well as the garbage bins. The sofa (Figure 33) received a vast amount of both hearts and fires with explanations like: 'nice to sit in',

Figure 32. Activity #1: Re-boot! (opposite page)

'comfortable to work in', 'you can sit here, if you feel a little "down"', 'it is completely smashed and hard, but it is still wonderful', 'worn-out', 'hard to sit in' and 'not very pretty' (my translation). The semi-circular table was liked because 'it was cosy', 'you could sit together' and 'it was a good place to work' (my translation). The garbage bins were disliked because the recycle system was complicated and the bins were sometimes smelly.

The activity visualised how the same spatial element can be experienced differently by different people. Before the activity, the teachers only saw the ugliness of the worn-out sofa (teacher T, personal communication, 20 March 2018) but the activity made them aware of the students' experiences and priorities. During the interview (2 July 2018), teacher T explained how the activity had made her realise how different the students' preferences are and that the same spatial elements can be both liked and disliked. The same contradiction applied to the semi-circular table, which was never used according to the teachers (teacher T, personal communication, 20 March 2018). The fact that many students 'hearted' the table raised the question of why it was not used in the educational practices and created a basis for discussion about the reasons. Were they practical, pedagogical, organisational or did the students reflect and act in different ways, meaning that they liked the table when reflecting on it but did not use it in reality?

Activity #2 brought attention to the spatial qualities and functions in the actual learning space, which was then used as a foundation for the discussions in the next activity.

Activity #3: What activities should you be able to do in a learning space?

The next step was dealing with learning activities from a more general perspective. Each participant was given a bunch of post-it notes and asked to write as many activities as they could come up with—one per post-it note. Subsequently, the students gathered in groups of four to categorise the activities. Before doing this, they were told to choose a place to work when collaborating—some chose the windowsill, some the sofa behind a pile of materials, some the different tables around the learning space

including the semi-circular table and others chose to sit in the hallway in a small group space. This was also a way to make explicit the affordances of the learning space.

Afterwards, they were given a stack of pictures and told to choose one picture per category. The picture could either represent the category in a very direct way, e.g. a learning environment that fits the activities of the category or represent the category in a more symbolical manner (Figure 34). Finally, we gathered in the middle of the space around the long table where each group presented their categories and pictures to the rest of the class. The activities were mainly sorted under similar categories like creativity, experiment, presentation, concentration, movement, collaboration, working alone and more subject-specific activities like reading, math, writing etc.

The purpose of the assignment was to create deliberate reflection about the variety of learning situations that a learning space could and should support. This was meant as a basis for the final activity of workshop #1 in which they had to build a model of a 'dream learning space'.
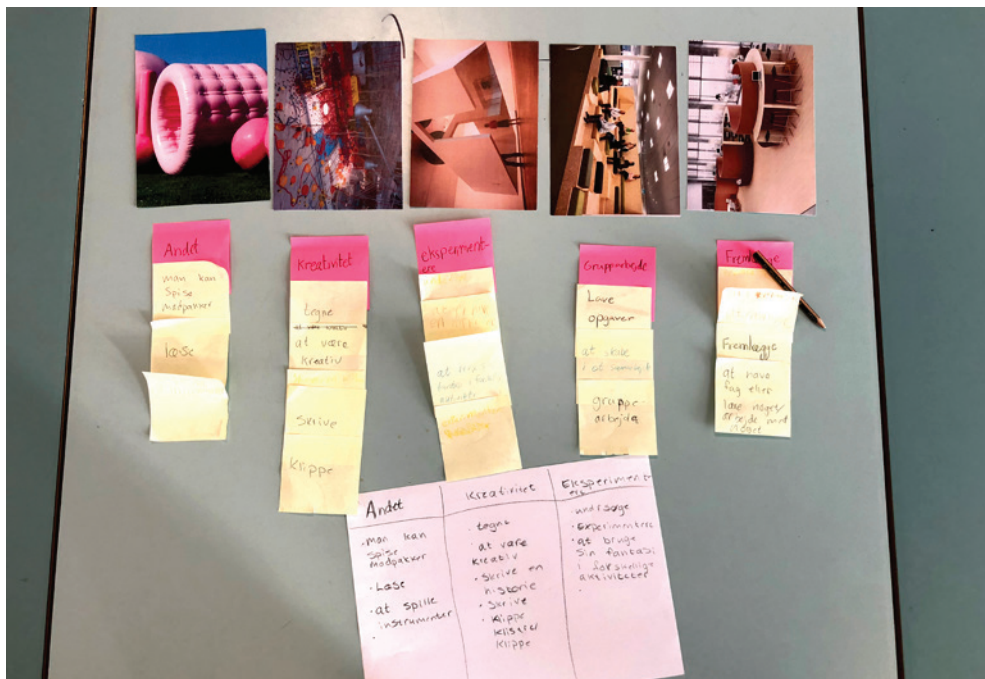
Figure 34. Activity #3: What activities should you be able to do in a learning space?
Students listing and categorising activities

Activity #4: Build your dream learning space

The last step was a collaborative exercise combining the results from the previous activity with a practical, hands-on exercise. In groups, the students were engaged in participatory prototyping as they were building models of their dream learning spaces based on the categories they listed in the previous assignment. 'Participatory prototyping' is a means to explore, express and test hypotheses about future ways of living in mock-ups or models, as explained by Brandt et al. (2012) and Sanders (2013). Each group used a generative toolkit consisting of a rectangular piece of foam board and a large amount of different materials to choose from (Figure 35a and 35b). As Sanders and Stappers (2014) explain, the generative toolkit can be used to explore future experiences in a 'my-ideal-future-product exercise' (p. 12), which in this case was the ideal future learning space.

Figure 35a and 35b. Activity #4: Build your dream learning space: A wide range of materials were part of the generative toolkit

Figure 36. Activity #4: Build your dream learning space: The building process

The aim of the activity was to make the students discuss and reflect upon the qualities and affordances of a learning space in collaboration while building: Which learning activities are important and how do we create a space for them? (Figure 36) At the same time, the assignment was meant to visualise the needs and experiences of the students to the teachers.

Unfortunately, the time schedule was too tight, which meant that the students did not finish the last activity during the workshop. However, the students continued working on the models after the workshop together with their teachers (without Rune Fjord and me). After finishing the models, they reflected upon the designs by discussing pros and cons in the class and subsequently sent photo documentation to me. When visiting the school for workshop #2, we saw the models of the learning spaces, which were displayed in the school library (Figure 37a, 37b and 37c). In general, the students made very advanced models and mixed dreams, e.g. a football field and a foam pool, with more traditional learning activities and furniture (soft places to sit, writing boards, tools etc.). None of the students built traditional classrooms despite working in a fairly traditional classroom themselves.

The last activity showed that the students were very capable of reflecting upon

their needs in relation to their own learning when they were given the tools to assist in the process. As explained in the previous chapter, co-design has the ability to assist in making thoughts and ideas into something visible and communicable, which is exactly what happened in this activity. Moreover, the students were not restrained by realistic frameworks (like most adults) and could mix fantasy with actual needs, which made the model designs very varied and interesting.

Summary, workshop #1

Overall, workshop #1 was found to establish a forum for exploration and reflection about space and practice that worked on the level of the students' knowledge and competencies. The bodily explorations of the space, the reflections on the spatial qualities and the listing and categorising of learning activities were found to create a common ground and language to build a new learning space (model) on. Without the preceding activities like e.g. the listing activity, it might have been more difficult for the students to build an imaginative learning space that did not just reflect their current space. This in turn provided insights into the students' experience of the spaces in relation to their learning situation preferences.

During the workshop, different aspects of practice, space and organisation were addressed, both through the overall setting of the space that was changed to match the workshop activities and through the various activities. Most dominant were the issues of space and practice; however, even the issue of the organisation was present as the adjoining learning space was included in the activities. This provided the class with more space and more flexibility. At the same time, it highlighted the organisational issue with the shared space as the other classes were told to stay away.

The mid-way workshop #2

The second workshop took place midway in the process, approx. two months after the first workshop, and had two purposes: to reflect upon the process that had passed and to continue the discussion about the relationship between learning space

Figure 37a, 37b and 37c (opposite page) Learning space models made by the students
in school B during and after workshop #1

and pedagogical practices. Whereas the first workshop dealt with a more holistic examination of the relationship between the learning environment and the users, mainly the students (their experience of the qualities of the space, their understanding of learning activities and desirable spatial requirements for different activities), the second workshop went more into spatial details by focusing on creating a single piece of furniture that would support one or more learning situations in relation to the actual learning space. The reason for this was that we wanted to create a more direct connection between learning activity and spatial design.

The generative toolkits in workshop #2

Once more, the participants were working with generative toolkits containing a wide range of materials. The participants worked in a combined telling and making activity in groups of four.

Co-design activity: Build a piece of learning furniture

The assignment was to design a prototype of a piece of furniture that would cover one or more needs in relation to the physical learning environment. The students were told to follow a four-phased design process model with a specific time allocated for each phase. The reason was that we wanted them to spend time discussing and reflecting on space and practice instead of rushing into the actual building process.

The aim was to make them reflect upon and discuss their actual learning environment and the learning activities it supported—or did not support—in small groups, as well as gain insight into each other's needs and preferences in various learning situations.

The intention of the workshop was to explore what the students considered as the most important spatial qualities in relation to their learning situations, and whether having them build a furniture prototype would provide the teachers with more insight into the needs and experiences of the students in relation to the interplay between learning activities and space.

Figure 38a-38f (opposite page). Prototypes made by the students during workshop #2
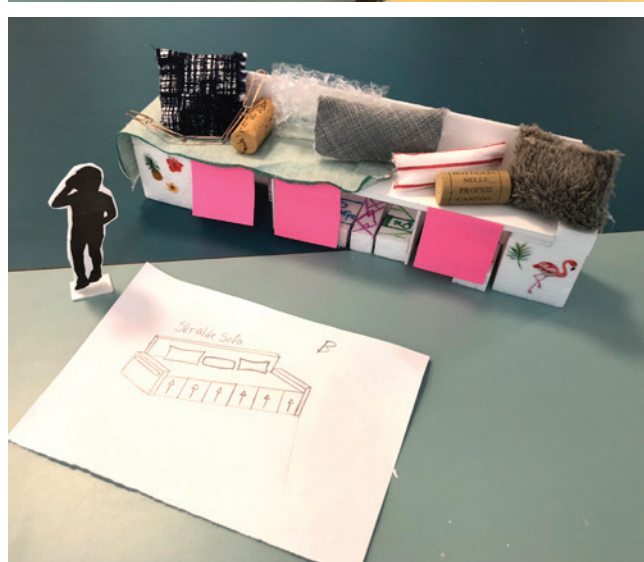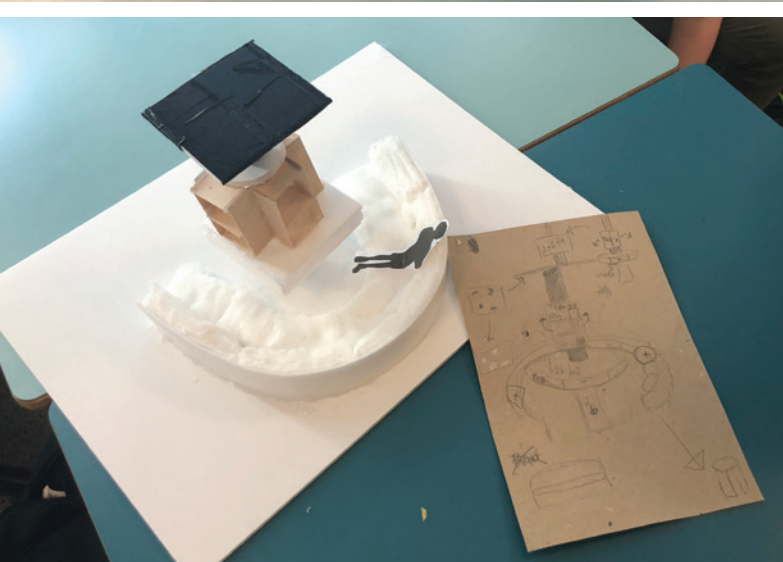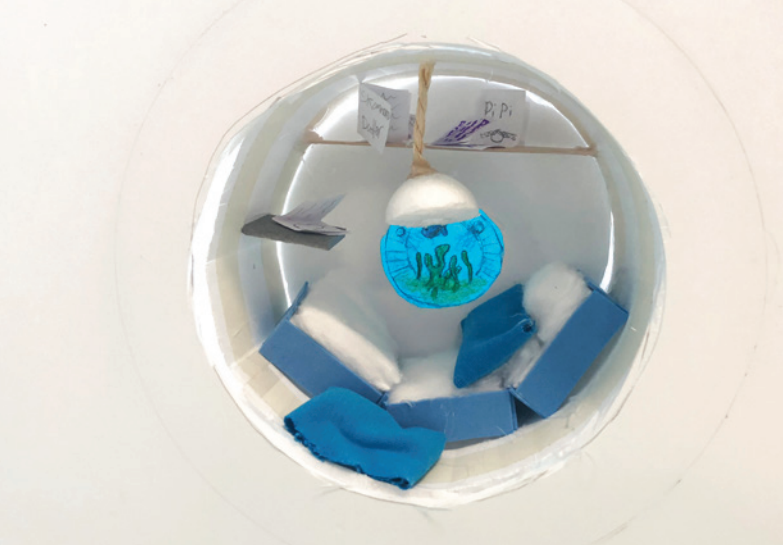
The students built six very varied types of multifunctional prototypes of furniture—at least visually. However, when looking into the functions and underlying needs, they were not that different. The most dominant need turned out to be tranquillity and concentration, which most groups solved as a multifunctional space or furniture that provided a soft place, where they could withdraw to work in a concentrated fashion or relax (see Figure 38a-38f). This need was backed up by the teachers in the following interviews.

Summary, workshop #2

In the second workshop, the students were reflecting in more detail on the qualities of their actual learning space in relation to practice. The activity forced them to look at the spatial qualities and relate these to their own preferences and needs in learning situations in order to identify a problem and create a solution. Both the process and the physical prototypes accentuated the needs of the students in a very accessible and visible manner and thereby potentially provided the teachers with new insights on space and practice.

The workshop focused on space and practice in a direct manner through the prototyping activity. More indirectly, it brought forward the issue of organisation in the physical prototypes of the students as they were addressing the needs for an organised spatial setting or a place to withdraw and relax during a long school day.

The evaluative workshop #3

The last and final workshop focused on evaluating the project and the process and gaining more insight into the experience of the students and teachers. As time was limited in this workshop, it only consisted of two assignments as well as a brief reflection session neither of which included co-design activities. Instead the students were given a form and a questionnaire both of which were aimed at collecting data for the research project.

In general, the last workshop was experienced as less productive, reflective and activating than the first two workshops, which might be explained by the choice of assignments lacking the co-design approach. In the first assignment the students

had to match and rate learning activities with 18 pictures of learning spaces on a piece of paper in groups of two. The intention was to create reflections about the relationship between the physical space and learning activities and collect information regarding their understanding of this interplay. In general, the assignment was too comprehensive and only few students made it through all photos. The assignment was less activating and hands-on than the previous co-design activities and was too introvert to catalyse the kind of reflections and discussions that this research project could have profited from. The students were also less active and enthusiastic this time and many of them had to be urged forward in the process. The reason for this is believed to be a combination of the format and the length of the assignment and the fact that the workshop took place just before the end of the term which meant that the students were tired and inattentive (this assumption was backed up by the teachers). The other assignment, the evaluation questionnaire, mostly reported back to Rune Fjord Studio and Højer Møbler with basic information about the students' experience of the co-design process and the use of the co-creation cabinets. Therefore, the last workshop did not provide much useful data for the research project.

Contrary to the previous workshops, the last workshop did not make use of co-design and as such did not activate the participating students to the same extent as earlier. This resulted in less exploration of the space-practice relationship, which in turn led to less information and data for the research project. These findings indicate that co-design has the ability to engage the participants in active exploration of the interplay between space and practice and as such become a tool in participatory activation. They even suggest that co-design is a valuable tool in constructive design research and emphasise the significance of the constructions in the research process. The potential of co-design in this process will be discussed further later in this chapter and in the following chapter.

The independent process

In between the three workshops, the class worked independently with the co-creation cabinets as tools in their everyday educational activities, which was documented in a visual logbook on Instagram. This resulted in creative assignments, like creating

percentage games in Math classes, 3D book reviews in boxes in Danish classes and a project and an exhibition about water goblets. Since this process mainly revolved around the co-creation cabinets, I will return to it in relation to experiment #3.

A co-design space as a place for learning space activation

In the following section I will use the concept of *the co-design space* to analyse the co-design workshops in order to understand the potential of co-design as a tool to inform the interplay between learning space and pedagogical practices. The concept is proposed by Sanders and Westerlund (2011), who argue that experiencing, exploring and experimenting in and with co-design spaces will add greatly to the understanding of design. This even applies to the understanding of design research, as I will show in the following.

According to Sanders and Westerlund (2011), the concept of the co-design space can be used in reference to different aspects of a co-design process. In order to distinguish between the three different ways of using the concept suggested by Sanders and Westerlund and apply them in relation to my research, I have named each aspect in this thesis based on their definitions.

A. In combination, the experienced physical space where a co-design process takes place, and the conceptual space (meaning the assignments and toolkits that are used in the co-design processes), create a framework for collective creativity, thereby becoming a co-design space (p. 3). In the following I call this *the material co-design space.*

B. The participants' activities constitute a co-design space through their situated practice and collaborative character, where they share experiences and generate ideas and proposals for the future (p. 4). In the following I call this *the social co-design space.*

C. The proposals and visions for the future constitute a solution space, a desirable co-design space that is located in the future (p. 4). In the following I call this *the desirable co-design space.*

I suggest that these three definitions create an entity, a complete co-design space that

accounts for the entire experience in a co-design event or process. In this manner, the concept of the co-design space can be used to understand the co-design process in its totality. In the following, I will use the three concepts to explain and discuss the co-design process and workshops in experiment #2.

In experiment #2, *the material co-design space* was established through a rearrangement of the spatial setting in the learning environment (the experienced space) and a carefully designed set of co-design toolkits and activities (the conceptual space). Together, they supported the participants in their co-design activities discussing current learning spaces and envisioning desired future designs. The experienced physical space where the workshop took place consisted of both the regular classroom and the common learning space next door, separated only by a folding glass wall. This wall was mostly closed as the space was shared with two other fifth grade classes located across the hall on the same floor. The wall was opened up in order to break with the traditional table-chair setting and create a large learning space with multiple types of workstations, e.g. a sofa, small group tables, a high table, the co-creation cabinets and the before-mentioned long table. The furniture was rearranged by moving all chairs to the walls of the space and placing most of the tables in a long line in the middle of the space. Different activity stations were created in the space of which some changed during the workshops. For the first activity, a long piece of paper was rolled out onto the middle table, which later changed into several workstations for telling and making activities in groups. Several places in the space were prepared as co-designing stations with multiple materials or creative tools like scissors, glue and drawing tools. Thus the experienced physical space was laid out to support the conceptual space. The rearrangement was important because, as Sanders and Westerlund point out, the physical environment can also have a negative impact on the co-design work by obstructing collaboration or otherwise complicate the co-design activities. In this case, the rearranged space provided a flexible setting for the co-design work of the participants and gave them the opportunity to try out different workstations during the workshops as opposed to their usual classroom setting. The arrangement of the space, as well as the sequence of activities, was carefully designed to match each other and create a total experience for the participants.

The social co-design space was created during the situated and collaborative practices of the workshops, where the participants were working together to explore their current learning space and practice and generate proposals for desired future learning space designs. The students were the most active participants in the process, often working in groups of four, whereas the teachers took on a more observing role in the activities. This resulted in the students learning from their own reflections, while the teachers learned from the students' reflections. The carefully designed co-design toolkits and the planned activities helped engage the participants in different telling and making activities that were anticipated to create enhanced awareness about the actual learning space and the pedagogical practices taking place in the space. According to Sanders and Westerlund, the co-design work needs to be accounted for and prepared for as the participants should be able to contribute on an equal basis. In the workshops, I experienced that the co-design toolkits and activities helped the students relate to their own experiences, thereby making it possible for everyone to participate in the activities irrespective of their previous knowledge of design or pedagogies. The hands-on activities (building) provided space for a more explorative process that every student could participate in.

Finally, *the desirable co-design space* was established in the proposals and visions for the future that the participants visualised in their learning space models and furniture prototypes. The students co-designed future learning environments where they would like to study themselves which, according to Sanders and Westerlund, is a desirable co-design space.

The co-design space in its entity addressed the interplay between space and practice from different angles. By collaboratively reflecting on their own practices and space (*the social space*) while working with co-design toolkits in their rearranged learning space (*the material space*) and building desired future learning spaces and furniture (*the desired space*) the participants gained insights into the relationship between space and practice. As one of the teachers noted in the interview later 'I can see something is happening to the kids when things are done differently. There is a different interaction between them; there is also more freedom' (teacher T, personal communication, 2 July 2018, translation from Danish).

According to Sanders and Westerlund, the co-design space mostly takes place in the pre-design phase and is dependent on the participants' ability to take part in the collaborative practice. As this experiment proposes, the co-design space could even be established in an activation process to frame a collective and creative exploration of the interplay between learning space and pedagogical practice. The co-design space becomes a means to activate the space by providing a framework for discussion of current and future practice in relation to the physical learning environment. This, I would argue, turns co-design into a potential tool in activation processes of learning space designs, which I will elaborate on in the next section.

Looking at the co-design workshops in an activation process through the lens of the concept of the co-design space helps create a total picture of the process. This has helped me understand the correlation between the individual parts of the co-design workshops. Potentially, this can also help in the planning of future workshops. As Sanders and Westerlund state, it is necessary to have a discourse to be able to plan, conduct, understand and learn more about co-design activities. As mentioned earlier, Sanders et al. (2010a) likewise emphasise the importance of considering the total experience when planning co-design activities. I would argue that the co-design space as a concept can help the designer in the planning of the co-design workshops by providing a 'check list' that will help ensure a total experience for the participants. Subsequently, this also has the potential to inform the interplay between learning space and pedagogical practice. As stated in the beginning of this thesis, I do not examine a particular type of learning space or pedagogical practice as my interest lies in the relationship between a given space and a given practice. Assessing spaces and practices would require a deeper examination of the impact of specific learning space layouts and particular pedagogical practices on learning outcomes, which is beyond the scope of this project.

Activating learning spaces is an experiential and participatory process

When comparing experiments #1 and #2, I experience two different parts of the design process and two very different roles of both users and designers. Experiment #1

displayed a fairly traditional design process, where the users were meant to participate but never did and thus ended up playing an insignificant role in the designing of the new learning space. Experiment #2 took place in a new phase after the implementation of a learning space design and unfolded in very close collaboration with the users, who were the main actors of the process. In the first experiment the designers played the main role as creators of the new design, whereas the designers were more peripheral in experiment #2 as facilitators of the co-design workshops.

As stated in the introduction to experiment #2, the aim was to explore the potential of co-design as a tool to activate learning space designs in collaboration with the users in order to answer the research question: *How can approaches from co-design inform the interplay between pedagogical practices and learning space design and the transition into new learning spaces?*

In the following, the findings from the process are divided into four themes in an attempt to shed light on the potential of co-design in relation to activation of learning spaces:

1. Co-design as a tool in experiential activation of learning spaces;
2. Co-design as a tool to enhance environmental awareness and competence;
3. Co-design as a tool for communication and collaboration;
4. Co-design as a tool to transition into new learning spaces.

Co-design as a tool in experiential activation of learning spaces

In the description of the workshops and the analysis of the workshops as a co-design space, I have tried to show how the approaches from co-design have contributed to the relationship between space and practice. Based on my own observations as well as the interviews with the teachers, I claim that the co-design approach helped create a connection between the physical learning space and the actual pedagogical practices in the participating class. The material co-design space (co-design toolkits and activities) was experienced to provoke discussions about the learning space and learning activities in an accessible way for the participants as they were often reflecting in action. This became evident in both the discussion during the activities as well as the constructions made by the participants. According to Schön (1983), doing

and thinking are complementary when reflecting-in-action and each act feeds into and sets boundaries for the other. This way of learning by doing is also called 'experiential learning', which Lewis and Williams (1994) explains as:

> *'In its simplest form, experiential learning means learning from experience or learning by doing. Experiential education first immerses learners in an experience and then encourages reflection about the experience to develop new skills, new attitudes, or new ways of thinking'. (Lewis & Williams, 1994, p. 5)*

The experimental approach provided by the co-design activities was experienced to create a natural connection between the learning space and the pedagogical practices. David Kolb, one of the main researchers of experiential learning, proposes that learning takes place in a four-step process: At first, the learners should gain concrete experiences and then reflect on these from a variety of perspectives. Following the reflective observations, the learners should engage in abstract conceptualisations, where they create generalisations or principles that integrate their reflections into theories. Finally, the learners should use these generalisations as guides to engage in active experimentation, where they test what they have learned in other more complex situations. This is believed to be an iterative process where the four-step process is continuously repeated (Kolb, 1984, as cited in: Lewis & Williams, 1994).

Overall, the process of experiment #2 followed this four-step process proposed by Kolb, as the students and teachers moved from concrete experiences, reflections and conceptualisations in the workshops to active experimentation in their independent working periods. On a minor scale, the same structure applied to workshop #1, where the students, followed by the teachers, likewise moved from concrete spatial experiences, to reflections and conceptualisations on space and practice and finally to active experimentation as they created models of learning spaces.

I experienced that the combination of hands-on practice, reflection-in-action and relating the tasks to the everyday life of both students and teachers helped create an awareness about the relationship between space and practice. The many co-design activities during the workshops as well as the use of the co-creation cabinets (which

I will return to in experiment #3), aka the social co-design space, made both students and teachers reflect upon their surroundings through active experimentation. This was expressed in the post-process questionnaires and interviews as well as revealed during my observations. I witnessed how the discussions in the individual groups and presentations in plenum, as well as the actual products and prototypes made during the workshops, produced a lot of information regarding the students' experiences and needs in relation to the physical learning space and their wishes for the future, the desirable co-design space. This, in turn, made the teachers reflect on both the physical space and on practice, as displayed in the interviews.

In my opinion, knowing your own preferences in a learning situation and talking about learning in general can seem very abstract for a fifth grader. In the creative processes of the co-design activities, the abstract subject became more concrete by referring to the participants' own experiences regarding the layout of and practice in their own surroundings. The co-design tools, materials and techniques helped them discuss the abstract subject of the relationship between space and learning activities as they were exploring and building very concrete objects. I experienced that the students were highly engaged in the workshops, which was backed up by teacher T. In the interview, she told me that she was positively surprised by the enthusiasm of the students. She also commented that it was interesting to experience how their level of frustration was lowered, when they really wanted to do something (personal communication, 2 July 2018). This, I would argue, also substantiates my assumption that co-design can be used as an approach to engage the students in activation of their learning spaces in collaboration with the teachers. The process of activation becomes a joint learning process. Together, the telling and making activities, aka the social co-design space, created a common basis for discussion and reflection about the experience of the learning space and the needs of the individual students. In turn, this was experienced to provoke a wider awareness of the relationship between space and practice in the teachers as they followed the students' discussions and explorations of their learning space in relation to their own learning activities.

Co-design as a tool to enhance environmental awareness and competence

The insights obtained through the co-design activities could potentially help train the teachers in becoming more aware of the qualities of the space and thereby develop environmental competence, as requested by Martin (2002; 2004) and Lackney (2008). According to Martin, it is necessary 'to give teachers greater authority in designing and redesigning the spaces in which they teach' (2004, p. 87). She claims that the process of designing classrooms is hierarchical with the architect providing a 'finished beginning' (p. 87), which, along with the fact that teachers often inherit their classrooms, has led to a tendency of teachers passively accepting their inherited classroom designs. In order to change this, the teachers' environmental awareness and knowledge about the relationship between space and practice should increase, which is why teacher training in understanding the effects of the classroom on practice is important (Martin, 2004). Martin focuses on the relationship between the classroom and practice, but I would claim that her insights also apply to other types of learning spaces.

Exploring the potential of co-design as a tool to develop the teachers' awareness of the spatial possibilities and the impact of space on their teaching and the students' learning was one of the main aims of the co-design workshops. As explained in the previous sections, the teachers started reflecting on the relationship between space and practice as a result of the co-design activities with the students and their own practice with the co-creation cabinets in-between the workshops, thereby creating a social co-design space. The subsequent interviews with the teachers indicated that the co-design process had pushed them into thinking more about their own practice in relation to the physical surroundings and the various factors that influence this relationship. The teachers appeared to be quite aware of the relationship between space and practice, especially in relation to the students' need for different spatial settings during the day and in different learning situations. They both claimed to think a lot about this and were very conscious of the spatial qualities like acoustics and furniture and how these affected the students. Still, they did not alter the classroom setting much during practice (it consisted mostly of chairs and tables). Instead, they told me, they used the school areas outside the classroom as breakout spaces.

The reason, they claimed, was the limitations in the size of the classroom and the furniture (*space*) as explained by Teacher F and lack of time (*organisation*) as explained by Teacher T, which prevented them from rethinking the setting of the classroom. Teacher T also told me that the co-design process had made her aware of how 'locked' she was in her teaching (*practice*) and that she was 'very good at getting ideas' (also relating to the space, my note) but bad at implementing them (teacher T, personal communication, 2 July 2018). Teacher F claimed that he had always been aware of the physical environment and spatial layout and its impact on the students' learning (teacher F, personal communication, 26 June, 2018). He often thought about the way the space was being used, but experienced that this was highly constrained by the fact that there were several teachers using the same space:

> *I've probably always thought [...] that it is important [...] I've often wondered how and in what way to place the furniture differently, so in a way I believe that I've had an awareness about the physical environment, thought a lot about how to use [...] the space in a different way. [...] I believe that this is something I've always been aware of, how such a space works, because I think it is very relevant in relation to what gets into their heads and how I navigate my workplace [...] the space, it often turns out in this way, you have some ideas about how and in what way it should be, then time passes [...] there are more people who use the space, then a mess is created with which you cannot really cope and everything ends in chaos. This is what happens with the classroom sometimes, I think. And it has to do with the fact that there are more people using the space [...] Then there has to be something on the board referring to Math, then there has to be something referring to German and then you have your own idea about how it should look and suddenly there are German words everywhere [...] it just makes you abandon the idea about how this space should be.... (Teacher F, personal communication, 26 June 2018, translation from Danish)*

The statements and the quote indicate that it was not a lack of awareness that kept the teachers from using the design of the classroom space as an active tool in their teachings. Rather, the awareness was overruled by other factors, which had made

the teachers quit trying to alter the actual learning space. Besides the reasons stated above, both teachers also expressed a fear of letting go of control because they found it difficult to balance different student needs of structure and freedom in learning situations. Teacher T called it 'school-teacher-anxiety' and both teachers called it 'classroom management'. The 'fear' limited the pedagogical practices in different ways, i.e. the students' free choice of workstations outside the classroom or the possibility of choosing their own groups (Teacher F, personal communication, 26 June 2018, translation from Danish).

This shows that despite having environmental awareness, the teachers were still very restrained when it came to their actual learning space and ended up passively accepting the layout of the classroom. They lacked environmental competence. This corresponds with Martin's assertion that environmental awareness does not necessarily lead to actions and that teachers tend to passively accept the learning spaces they teach in (Martin, 2004). As this section shows, the inaction not only stems from an inheritance of the space but also comes from other factors like time and space limitations, fear of letting go of control and sharing the space with other teachers. Following the co-design process, both teachers expressed intentions of working more actively with the classroom space in relation to their pedagogical practices in the future and to involve their colleagues in the process.

Summing up, I experienced co-design to provide the tools for collaborative discussions about the relationship between space and practice, which can help train the teachers in taking more control of their physical learning environment, as requested by Martin (2004) and Lackney (2008). Co-design has the potential to initiate discussions about imaginary and possible futures and make people look forward which, according to Lackney (2008), is an important component of environmental competence. The co-design approach offers a way of training environmental awareness and competence without dictating certain actions or pedagogies, because the learning process is collaborative and the teachers participate in the process as experts of their everyday teaching situations. Importantly, I would argue, the goal is not to tell the users how to use the space, but collaboratively work towards an alignment of space and practice.

Co-design as a tool for communication and collaboration

In the previous sections, co-design has already been proposed as a tool for communication between students and teachers. However, the use of learning spaces is not only dependent on the activities inside the learning space but is also influenced by various external factors. One of these factors is the shared use of the premises, which was experienced as a restraining factor in aligning space and practice by Teacher F. Several times during the interview he returned to this dilemma, implying that the spaces were used in an anarchistic manner where each teacher decorated the space according to his or her individual ideas and subject. This in turn led to a chaotic impression, which was experienced as limiting for Teacher F and bad for the students. In the end, it made him give up on changing the space and passively accept its chaotic setting.

I also experienced the dilemma with shared spaces during the workshops, where we changed the spatial setting to fit our co-design activities. We were told that it was very important to change it back to the 'normal' classroom setting afterwards, which was groups of chairs and tables, before the next teacher took over the space and class in order not to cause annoyance. I even experienced a lack of communication regarding the use of the adjoining learning space, which was shared between the three classes and mainly used as storage, because none of the teachers wanted to disturb the others.

The lack of consensus concerning the decoration of the space, use of the common space and limited flexibility can presumably be ascribed to a lack of communication between the sharing parties and an absent work culture (organisational issues) relating to the use of the spaces. If the teachers were to address these issues together, this could help align space and practice.

Even here, co-design activities could work as a tool for communication and discussion as it creates a common platform for the participants and provides the necessary tools. A carefully designed workshop will build common ground for communication between various actors, e.g. school management and teachers, which can make it easier to imagine and discuss the future, for instance the future use of space in relation to practice.

Co-design as a tool to transition into new learning spaces

Experiment #2 was imagined to take place in a post-design phase to help the users transition into new learning spaces. When building or rebuilding schools today, there is a tendency to reduce classrooms and build new types of open and flexible learning environments. The particular affordances of these new spaces rarely support 'classical' teacher-centred teaching practices, which is why a change from a 'traditional' school setting with classrooms to these new types of learning environments can be experienced as difficult (Bøjer, 2017, 2018). The appropriation phase will arguably be characterised by ambiguity, frustration and chaos as new practices and spatial settings are tested and matched.

The findings from experiment #2 indicate that co-design can be used to foster environmental awareness and bring focus to the potential of the space in supporting pedagogical practices, thereby becoming a means to help transition from one type of learning space to another. Co-design is believed to be a valuable tool in the transition process as it allows the participants to actively discover and explore correlations between space and practice and engages them in the exploration of open-ended questions concerning this relationship, as exemplified in experiment #2. Thus the activation phase resembles the fuzzy front end in the co-design process proposed by Sanders and Stappers (2008) with its many activities that aim to inform and inspire the exploration of open-ended questions. The activation phase, however, is to take place as a fuzzy back end to the design process and bridges to daily practices by suggesting and exploring new ways of combining space and practice.

Summarising the findings from experiment #2

In the second part of this chapter, I have described the process of experiment #2 and displayed my findings relating to the overall research question of this thesis as well as the specific research question associated with this experiment. The experiment has focused on exploring the potential of co-design as a tool to inform the interplay between learning space design and pedagogical practices with a particular focus on participatory activation of the learning space as a means to align space and practice. Summarising the findings presented in the previous sections of this chapter, the co-

design approach was found to:

- work as a tool in experiential activation of learning spaces by actively engaging the students and teachers in an experimental process, where they explored the interplay between space and practice in relation to their everyday life and practice.

- work as a tool for teacher training in environmental awareness and competence, as it brought forward information on the students' spatial needs and preferences in relation to different learning situations and made the teachers explore, discuss and reflect on space and practice.

- work as a tool for communication between teachers and students, but potentially also between a group of teachers using the same learning space. The co-design process creates an arena for communication and discussion where stakeholders can communicate across differences.

- work as a tool to potentially help activate and transition into new types of learning spaces as it provides activities and tools to explore and discuss new ways of combining space and practice.

Returning to the learning environment triangle, the co-design process was experienced to provide the tools to articulate the relationship between space and practice and hence, potentially contribute to an alignment of the three elements of the triangle: practice, space and organisation. The co-design activities and tools helped the students and teachers explore, discuss and activate different aspects of space, practice and organisation and imagine new ways to match space and practice, i.e. in the models of learning spaces and furniture built by the students. The teachers likewise explored this in their work with the co-creation cabinets, which will be discussed in the following section. Returning to ANT, the co-design process became an 'actor' in the learning environment 'network' as it made a difference to the space-practice relationship.

The interviews following the co-design process turned out to be valuable in the teachers' reflection process. During the co-design workshops they had mainly acted as supervisors, who observed and helped the students and did not participate directly in the activities. Neither did they have time to digest and discuss the results of the co-design activities together with us after the workshops. During the interviews, they were forced to reflect on space and practice and refresh their memories from the

co-design process in order to answer my questions. This contributed to an enhanced environmental awareness, which can be exemplified in this quote by Teacher F:

> *...this is why I'm thinking that to come out and start up something (like the co-design process, my note) can help us sit down and think about how and in what way we want to furnish our spaces. And whether we should include the students in the entire process or if they should be pushed into the process, that is up for discussion, but I think that a large part of the responsibility lies with us teachers, because anyway it is we who make the ultimate decision about what to hang on the walls and how it should look and we are really not good at that. And then you could say, well then, when we meet, when we have a meeting then there are other things on the agenda, but it is a significant thing to have on the agenda as well. I'm just sitting here while we talk, realising this more and more in reality, well, it really is. It is a pretty significant thing to have on the agenda. (Teacher F, personal communication, 26 June 2018, translation from Danish)*

This quote both displays the reflection process of the teacher and some of the insights he arrived at during the interview, which indicates a need for a follow up conversation after the co-design process. For this reason, in a future activation process of learning spaces, I would propose more time for teacher reflection and discussion following the workshops.
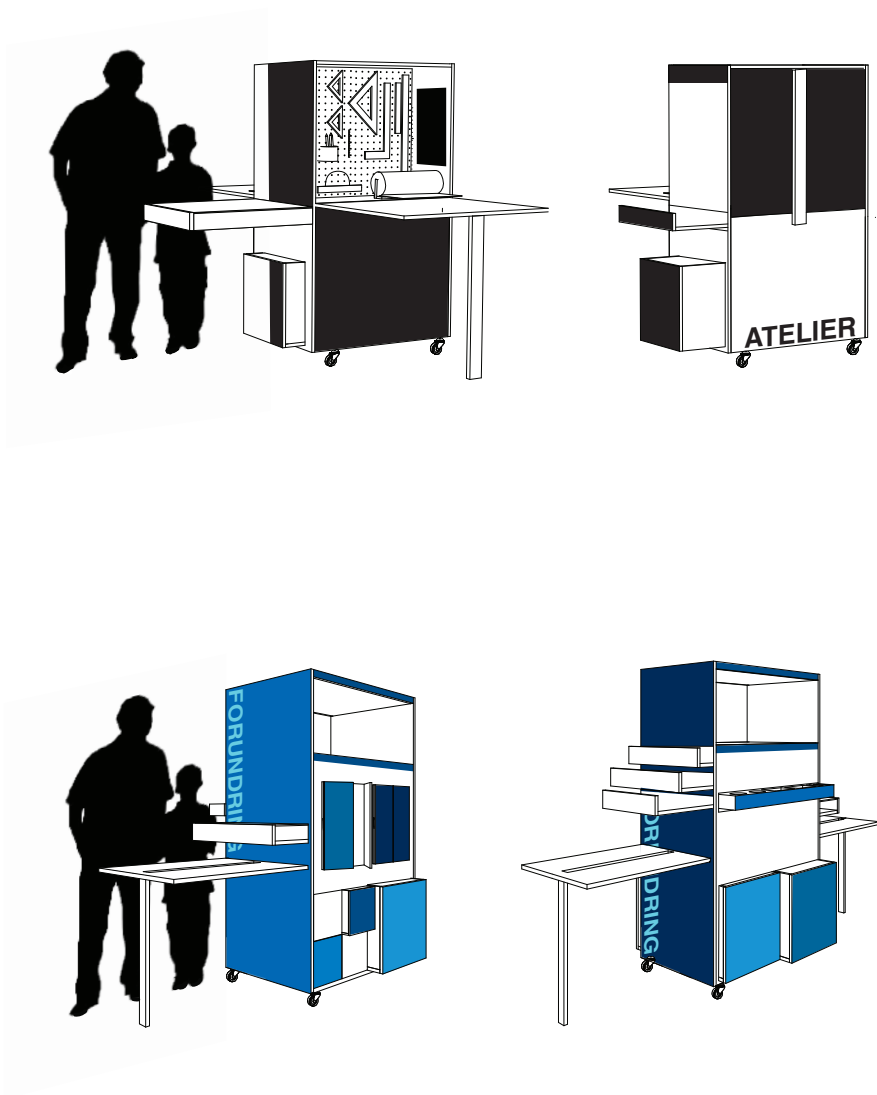
Figure 39 and 40. The Studio (above) and The Wunderkammer (below), design drawings

EXPERIMENT #3 / THE DESIGN (PROTOTYPES)

The third experiment is closely connected to the two previous experiments, as it took place simultaneously and grew out of experiment #1. As explained earlier, part of the purpose-built learning space design developed especially for school A were two co-creation cabinet prototypes with different functions that could be unfolded (Figure 39, 40). These prototypes were copied with minor adjustments (mainly based on economic considerations, as the producer wanted to make a cheaper version) and tested in school B.

The aim of the experiment was to explore the difference in use of the cabinets in the two schools in order to create knowledge regarding non-activation of learning spaces (school A) versus activation of learning spaces (school B). The cabinets became representatives of this activation process and worked as the constructions with which the research was conducted in line with constructive design research. Hence, the research question framing experiment #3 in relation to the overall program is: *What is the potential of spatial activation for the alignment of learning space design and pedagogical practices?*

The intentions of the design

According to Sanders (2013), the scene of design has changed over the last few years. The focus of design has shifted as all kinds of people have become interested in co-creation, design-thinking and creative practice. This, in turn, creates a need for new tools, methods and mindsets to support and inspire collective forms of creativity (Sanders, 2013). In my opinion, this also applies to the educational world. Schools are requested to educate students in a way that foster the development of 21st century skills, which are mainly considered to be the ability to collaborate, communicate, think critically and be creative. This places new demands on both space and practice—and requires new tools for participatory processes of both designing and activating space and practice.

The co-creation cabinets were developed as a response to this requirement and designed as tools to support learning processes that foster 21C skills. The first cabinet

was designed as a mobile design studio (The Studio) and contained a set of folding tables, a lightbox and storage space for materials and tools. It had to be equipped with a variety of materials and tools that could be used to inspire creative and explorative learning processes, thereby creating a framework for co-creation in schools.

The second cabinet was designed as a mobile exhibition and exploration space (The Wunderkammer) with exhibition facilities, a range of drawers, a sliding table and a magnifying glass that allowed for the cabinet to be programmed by the users. It was meant for use in a start-up process of a project or when presenting the results from a project and could be equipped with all kinds of materials relating to a certain topic. The purpose of the prototype was to inspire explorative processes and provide space for thematic work.

Prototypes

The co-creation cabinets were developed as part of a range of purpose-built furniture in school A and were not considered to be prototypes at first. Sanders (2013) describes the prototype as a means of bringing ideas to life before they are built or manufactured. This is a common praxis in design that allows the designer to test an idea before it is turned into a finished product. Traditionally, this has often been executed as a physical manifestation of a design object. In co-design, the concept of the prototype is broader as it relates to something being the first of its kind, which does not necessarily have to be a physical design object but can also happen in time through story-telling or scenarios (Sanders, 2013). As such, the co-design process in experiment #2 can also be explained as a prototype. Prototyping is significant in both practice and design research as it can be used as a tool to provoke discussions, test hypotheses and confront theories as well as the real world. According to Sanders and Stappers (2014), it even has the potential to change the world as it lets people experience a situation that did not exist before. The co-designers create the prototypes to envision and display their ideas in order to get feedback from other stakeholders (Sanders & Stappers, 2014).

In school A, the cabinets were included in the final learning space design as finished products and the project budget did not allow for any alterations. The design of the cabinets was developed based on our communication with the stakeholders during

meetings and workshops at school A as presented in experiment #1. The original idea for the cabinets evolved from another Rune Fjord Studio project with transformable cabinets that was presented to the former principal at school A long before the redesign project started. When he was introduced to the transformable cabinets, he enthusiastically expressed a need for similar cabinets that could travel between the classes and work as tools for the teachers in creative processes with the students. This became the seed of the idea of the co-creation cabinets (Figure 41a-b).

Following the lack of use of the cabinets, which we experienced at school A, Rune Fjord Studio, in collaboration with Højer Møbler, decided to reproduce a set of cabinets as prototypes and test their potential in two alternative schools. This happened for both commercial and scientific reasons. Besides their interest in the research results, Rune Fjord Studio and Højer Møbler also wanted to test the functions and design of the prototypes with future production in mind. Since my main interest was to use the prototypes as tools in my research on learning space activation, I was mainly involved in the first school testing project, school B from experiment #2. The co-creation cabinets were copied with minor adjustments and explored as design prototypes simultaneously and intertwined with experiment #2 (Figure 41c-d).

The cabinets can both be considered as prototypes in the more traditional sense, being a means to test an idea for a flexible type of furniture in learning environments prior to any manufacturing, but they also work as prototypes in the broader sense of the concept used in co-design. The prototype or prototyping is one of three approaches in co-design proposed by Sanders and Stappers (2014) and Brandt et al. (2012) that allows the participants to test future ways of living—or in this case, future ways of teaching and learning. In this context, the functions of the co-creation cabinets were more important than the visual design. The cabinets were not supposed to dictate a specific way of use, but were delivered to school B without a manual and with very little explanation of use. The teachers were told that the prototypes were educational tools and could support creative processes and project work. Apart from this, they were not given any directions regarding use, but were free to explore the possibilities of the cabinets in relation to their practices. The only requirement was that they documented the use in photos and brief statements on Instagram.
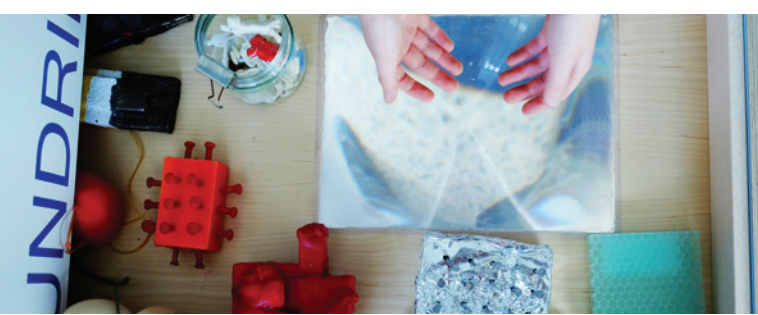
Structure of the experiment

Time frame and participants

The third experiment is divided into two parts of which the actual experiment is part 2. The co-creation cabinets were first installed at school A as part of the redesign project of the common street-space (experiment #1), but they were not taken into use for almost two years (March 2019). Based on this, experiment #3 was initiated at school B, where two similar cabinets were used in the co-design process and subsequently compared to the findings from school A. The participants in the experiment are mainly the students and teachers in experiment #2.

Documentation setup and data analysis

In experiment #3 the same data collection methods and data analysis are applied as in experiments #1 and #2. Since experiment #3 derives from experiment #1 and was performed intertwined with experiment #2, the data is identical. In experiment #3, however, the data material has been analysed with the prototypes as the main focus point. Once more, the learning environment triangle has served as an analytical tool in the discussion and analysis of the findings concerning the use of the prototypes.

The use of the prototype in school A versus school B

The cabinets in school A

As mentioned earlier, the co-creation cabinets were part of a larger 'package' of purpose-built furniture in school A. They were delivered to the school along with the rest of the spatial design and left for the users to activate and explore on their own based on the design proposal delivered in the design process. The cabinets came without any content: The Studio was supposed to be equipped with a set of materials and tools to use in creative processes by the school management, whereas The Wunderkammer was to be filled with learning materials by the individual teachers that related to the current themes they were working with.

*Figure 41a-41d (opposite page). The Studio and The Wunderkammer
in school A (above) and school B (below)*

As described earlier, the new learning space officially opened in May 2017. In June 2017 we held a status meeting with the school management to discuss the reception and the challenges of the new learning space design. At this meeting, it was agreed that we should return in August to attend a staff meeting with all the teachers from department B in order to communicate the intentions of the spatial design and help activate the space.

As described in experiment #1, the vice principal requested an activation of the co-creation cabinets a couple of weeks before the meeting. In response, we proposed a small activation workshop, where the intentions behind the design, including the cabinets, as well as the challenges the teachers were experiencing, would be discussed. The details of this workshop are described in experiment #1. The main findings from the workshop concerning the cabinets were that the teachers did not understand the intentions behind the design or that they were allowed to use them—they thought the cabinets belonged to the afterschool club alone. However, the club did not use them either. We also discovered another dilemma: The cabinets were designed with locks as requested by the school and there were only two keys for each cabinet. The keys were managed by one of the pedagogues and this person was only present during the afterschool club hours. This dilemma was communicated to the school management.

 As agreed with the vice principal, we also proposed a small 'home' assignment for the teachers during the workshop: One or more classes (teachers) should use the two cabinets in their practices during one or more weeks. They should document the process with pictures and present their results at the next staff meeting as an inspiration to others. This was agreed upon, but never implemented, presumably because it was not followed up by the school management. The management was also supposed to stock up The Studio with materials and tools, but this was not done for a very long time, and the co-creation cabinets stayed unused in the new learning space.

I continued to contact the school management concerning the use of the co-creation cabinets during the fall of 2017. In September, I emailed the vice principal, asking about the cabinets and whether I could join their staff meeting in November to follow up on the use of both the space and the cabinets. She replied: 'In regard to The studio cabinets, it is still a challenge—they have not yet been put into use,

but I will have to try to support them in this for a while' (Vice principal, personal communication, 19 Sept. 2017, translation from Danish). She also told me that they could not allocate time to talk with me at the staff meeting due to an upcoming theme week. A month later (27 Oct 2017), I emailed again, asking whether they had started using the cabinets or if we should send them a list of content to place in The Studio cabinet. I also offered to facilitate one or more workshops to activate the space, free of charge. 'The short answer to whether the carts are being used is no', was the vice principal's reply. However, the activation workshops were of interest.

The workshops were unfortunately never realised at school A. I sent a proposal for a co-design process similar to the one in experiment #2 to the school in November 2017 and resent it in December, where I was put on hold until after the Christmas holidays. By the end of January 2018, I was referred to a teacher, who was interested in participating in the process. We agreed to meet in February, but the meeting was cancelled due to her child being sick. She got back to me in April and we finally agreed to meet early May 2018. By then the summer holiday was approaching and the process was put on hold until the new term. Nothing happened until I approached the teacher in February 2019 to request news on the use of the learning space and co-creation cabinets for this thesis, at which time she apologised for 'letting me disappear into everyday life' (Teacher C, personal communication, 7 March 2019, translation from Danish). She then told me that the cabinets were still not being used but that she aimed to inspire the other teachers by using the cabinets for different projects in the common area during the month of March:

> *My strategy for inspiration is that in my upcoming topic (about Haiku poems ;-) I will use the cabinet a lot in the department (common area, my note). If the kids see other children doing something fun and different then they will also ask for permission to use it'. (Teacher C, personal communication, 15 March 2019, translation from Danish).*

Unfortunately, the effects of her activation attempts were not measurable within the time frame of this research project, which explains why they have not been included in this thesis.

As this section shows, organisational issues played a large role in the lack of use of the cabinets. The teachers had not been introduced to or trained in the possibilities of the cabinets and there were no clear frameworks for how and when to use them. Three months after the implementation of the learning space, they still did not know that they were allowed to use them. The key issue along with the lack of materials in The Studio were other organisational impediments that made the use impractical.

Relating to experiment #1, the lack of use of the cabinets could also be attributed to the lack of participation of the teachers in the design process, which meant that they had not been involved in the design of the cabinets, nor did they know much about the intended use. The physical design of the co-creation cabinets was not found to easily encourage and inspire the teachers to test new ways of practice, which might also be related to time constrains. As one teacher pointed out during the staff meeting in August 2017, the new design of the entire learning space (including the cabinets) demanded readjustments of practice and this was experienced as difficult. The affordances of the cabinets did not naturally correspond with the teachers' practice, presumably due to a lack of recognition and knowledge concerning the new and unknown design. From an ANT-perspective, the cabinets did not make a difference in the course of other agents' actions in school A (in this case, the teachers were the agents) and therefore did not obtain the role as actors in the learning environment network (Latour, 2005). This indicates that an activation process should be included in the design process of new learning spaces, especially when the users are poorly involved in the design process and the design and layout require a change in practice. I will return to this assumption later.

The cabinets in school B

In school B the co-creation cabinets were the focus of attention in a three-month process that included three co-design workshops. In between the workshops, the users (the class and the teachers) were working independently with the cabinets (examples in Figure 42). They mainly used the cabinets in Danish and Math lessons, where they worked with four major themes: 3-D book recensions, percentage games, goblets and sustainable cities (the latter theme was a cross-disciplinary activity with

the other two fifth grade classes). In addition, the students could use the cabinets for individual activities, which mainly consisted of reading, drawing and other minor everyday activities. The use was partially limited by the placement of the cabinets in the adjoining common learning space, which is mostly closed off by a glass wall due to shared use with the other fifth grade classes. However, the sliding wall between the two spaces was kept open more than usually in the process as part of the spatial activation (Figure 43).
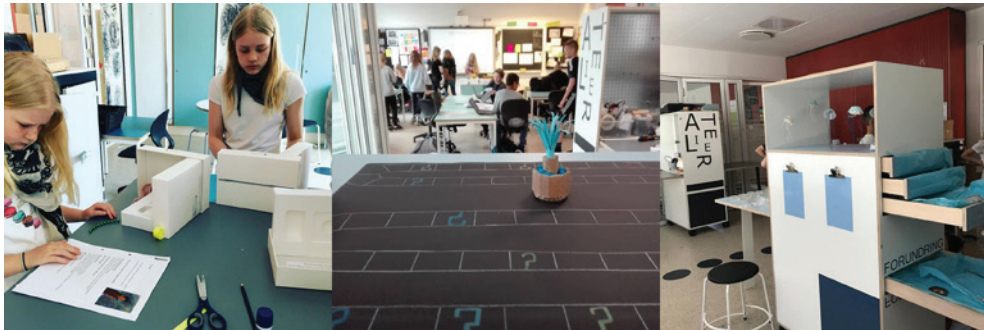
Figure 42. Independent use of the cabinets—book reviews, percentage games and goblet exhibition (from left to right)

Figure 43. The two spaces were connected by a sliding glass wall

In the first workshop, the two cabinets were activated as tools in the co-design activities. Both were placed in the adjoining learning space and filled with materials, tools and objects to use or inspire in the workshop. The Studio was filled with tools like scissors, cutting board, glue guns and cardboard, which the students used to build models of learning spaces and furniture in the co-design workshops. These materials and tools stayed in the cabinet for the entire three months of the co-design process, so they could be used in any kind of creative processes. The Wunderkammer was used as a piece of furniture for presentation and filled with material samples, objects and architectural models to inspire the reflections on space and practice. These related only to the first workshop and were removed after the workshop to allow the teachers and students to explore the cabinets in relation to their educational practices.

In between the three workshops, the teachers used the cabinets independently and without any directions from us. Despite being used in mainly Math and Danish lessons, Teacher T explained during the interviews after the termination of the process that the assignments in which the cabinets were used could actually be experienced as cross-disciplinary, linking the academic subjects with the artistic subjects.

> ...often the activities go beyond the border [...] they are interdisciplinary. The jellyfish (an exhibition where they explored jellyfish, my note), it was both [...] a little Danish-like, visual arts; it may actually have been anything. Sometimes they (the students, my note) are also so locked in those subjects [...] I like it when they can be mixed a little in reality...'. (Teacher T, personal communication, 2 July 2018, translation from Danish)

The teachers mainly used The Studio in their teachings and documented this through photos and small comments on Instagram throughout the three-month process. During the interviews, they both told me that the co-creation cabinets had pushed them into thinking and teaching in a different way. They related this to the mere existence of the cabinets in the space and to the commitment that they had made to us. In my opinion, however, this cannot only be ascribed to the cabinets; it also comes from the teachers' own ideas about the importance of creative and explorative learning, which we talked

a lot about during the interviews (Teacher T, personal communication, 2 July 2018; Teacher F, personal communication, 26 June 2018). However, as Teacher T told me, the cabinets had pushed her into implementing ideas about creative assignments that she might otherwise have let go because of the extra effort they demanded, compared to a traditional teaching approach. She also told me that experimenting with practice in relation to the co-creation cabinets had made her become braver in the sense that she dared let the students work more experimentally and less 'model-crafting' (which means following instructions).

Working with the cabinets also fostered discussions about creative thinking and creativity as a broader concept, according to teacher T. She described how the discussions with the students moved from talking about creativity as a pure practical cut-and-glue act to creative thinking as a problem-solving activity (Teacher T, personal communication, 2 July 2018). She ascribed these discussions to the presence of the cabinets, which she claimed had affected and inspired her to address the issue of creativity. Teacher F likewise experienced that The Studio cabinet had pushed him into working more creatively with Math assignments, which he saw as an important development of the subject.

> *I am a Maths teacher, it forces me to, all the time, keep an eye on the wagon (the Studio cabinet, my comment) in relation to the things I have to teach, it means, how and in what way can we in my teaching be different, how can we become more creative [...] the creative dimension should be more present in Math, it actually already is, but then you have to go to the visual arts room and pick up something.... (Teacher F, personal communication, 26 June 2018, translation from Danish)*

As the quote by teacher F displays, the affordance of The Studio cabinet made it easier for him to bring the creative dimension into the Math subject as the cabinet contained both materials and a workstation for creative work, which might otherwise have required a visit to the visual arts space.

The Wunderkammer was not used nearly as much. Teacher F told me that he had not used it at all and ascribed this to the cabinet being partly broken, as well as it being

more difficult to use as it made a bigger intervention into his teachings:

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> *Maybe it demands something else. I mean, the other one is a little easier to go to and stand and build at and so on, but, I don't know, a better manual or that you get pushed a little more in a different way into using it, challenged in it... [...] you can also say that we were challenged as it didn't work properly, but no matter what, it would probably be more difficult to use, because it is more of an intrusion into your teaching than the other one .... (Teacher F, personal communication, 26 June 2018, translation from Danish)*

However, it was not The Wunderkammer that had a broken part; it was the lightbox in The Studio that was not functioning, which indicates that Teacher F had given up using the cabinet in advance. As the quote shows, he also requested a better manual or activation of the cabinet to help and challenge him into using it. Teacher T used the cabinet one time for a jellyfish exhibition, which she made with the class and presented to the youngest students at the school. However, she experienced the same challenges as Teacher F:

> *I think it has a lot of potential, the exhibition cart (The Wunderkammer cabinet, my note), but it is bloody difficult to crack [...] it would be so obvious to let them explore it but once more it is time-consuming and tidying it and so on... (that limits the possibilities of exploration, my note based on earlier in the interview) (Teacher T, personal communication, 2 July 2018, translation from Danish)*

These comments and reflections have led me to assume that the more the new design differs from traditional furniture and thus demands a change in practice, the more important it is to support this change i.e. through activation. Both cabinets were activated in the co-design workshops, but the activation of The Wunderkammer was not sufficient for the teachers to be able to use it. The teachers in school B were used to working with creative assignments and could immediately include the functions of The Studio into their current practice, whereas The Wunderkammer demanded

more of them in terms of a changed practice, which in turn demanded time to change practice. Lack of time (an organisational issue) was a big constraint for teacher T in terms of experimenting with the physical environment, which she returned to several times during the interview.

The importance of the commitment

Based on the previous descriptions and analyses of the use of the co-creation cabinets in school A versus school B, the major difference in use can be ascribed to the commitment of the teachers in trying out new practices. In school A, the teachers did not take part in the design process and never agreed to use the co-creation cabinets. In school B, the teachers chose to participate in the co-design process and to explore the co-creation cabinets in relation to their practice, thereby experimenting with both prototypes and practice. As Teacher F explained: '…we were thrown into a project and then, of course, you commit yourself to sort of opening your eyes to it (the cabinet, my note) being there and all that. We were not thrown into it, we really wanted it…' (Teacher F, personal communication, 26 June 2018, translation from Danish).

The commitment of the teachers in school B played a vital role in the actual use of the cabinets. Still, the fact that the teachers only used The Wunderkammer cabinet once shows that additional factors (or actors, to use ANT), other than the commitment, play a role in the relationship between space (prototypes) and practice. In this case, the organisation (lack of time) was a major obstacle that kept the teachers from experimenting with the use. The function of The Wunderkammer cabinet differed more from their actual practices than the function of The Studio, thus demanding more in terms of changed practice. This, in turn, called for allocating their spare time to experiment, which the teachers did not feel they possessed. The same challenge, lack of time, was found in School A. Once more, the balance between space, practice and organisation was found to be important for the actual use of the physical environment.

Summarizing the findings from experiment #3 in relation to the other experiments

Experiment #3 shows a clear connection between the commitment of the teachers and the alignment of learning space design and pedagogical practices. The active choice to participate and try out new practices was significant in the process of alignment, which the comparison between the use of the cabinets in school A and school B demonstrates. The cabinets were basically the same, but the use (or lack of it) differed. Relating to the research question connected to experiment #3—What is the potential of spatial activation for the alignment of learning space design and pedagogical practices?—I would argue that experiment #3 points to a strong connection between the process of (participatory) activation and the way a spatial design (and the space) is used. If the teachers in school B had not chosen to participate and if they had not been actively involved in exploring the potentials of the spatial design, the cabinets might have ended up unused in a corner like in school A. The commitment pushed the teachers into the process of actively exploring the cabinets in relation to practice, which made them more conscious about the relationship between space and practice and the potential of the spatial design as a tool. This, in turn, contributed to the development of their environmental awareness and competence.

The combination of workshops and co-creation cabinets in the co-design process challenged the teachers both spatially and pedagogically. The workshops created reflections about space and practice based on the co-design activities with the students, whereas the co-creation cabinets actually pushed the teachers into working differently due to the commitment to include the cabinets in the educational activities. This resulted in a more flexible use of the learning spaces as well as more creative assignments. In a conference proceeding from 2018, I argued that

> ...the combination of reflective and practical work in the actual learning environment of the users created an extra dimension of understanding that they would not have gained if either workshops or co-creation cabinets were used independently or separated from the actual learning space. (Bøjer, 2018)

I still believe this to be true. Similar issues and challenges relating to practice, space and organisation were discovered in the three experiments, i.e. the constraints of time, an organisational element, the participation of the teachers in the design process, which then led to a disconnection between space and practice in experiment #1. Lack of time was likewise a challenge in experiment #3 that constrained the teachers from experimenting with the use of the cabinets. Another challenge that surfaced in the experiments was the sharing of the learning facilities with other teachers and the lack of communication and development of a common culture for use (organisational issues), which constrained a more flexible practice. The support of the school management also played a role in the activation of the learning spaces as experienced in all three experiments. In experiment #1, the intentions of the new learning space and co-creation cabinets did not match existing practices and it was not until the school management actively started supporting and taking control of the activation of the space and the spatial design in relation to practice that a change was initiated. In experiment #2 and the second part of experiment #3, both taking place in school B, the process was initiated and supported throughout by the school management.

A difference in the two schools of potential influence to the level of engagement of the teachers in the exploration of space and practice is the fact that the design in school A is permanent, whereas the design in school B was temporary and part of an experiential process. Potentially, this has made the teachers in school B more open to explorations and testing of new practices as the project might have been considered less 'dangerous' relating to its temporary status. On the other hand, one could argue that the teachers in school A should be more interested in trying out new practices in order to create a match between their physical environment and practices, since the design was there to stay. This, however, was not the case.

PARTICIPATORY ACTIVATION

Ideally, when designing new learning spaces, teachers and school management should be engaged in the entire design process in order to ensure alignment of space and practice. In reality this kind of comprehensive participatory process is difficult to

undertake as experienced in experiment #1, which might leave the users with a learning environment where the intentions of the design do not match the expectations and established practises.

To remedy this dilemma, I have proposed an additional activation phase in the design process after the new learning space design is implemented, where the intentions of the spatial design are translated into actions and negotiated through appropriation with the users. The purpose is to match practices with spatial possibilities—and spatial possibilities with practices.

In experiments #2 and #3, this activation phase was explored through the use of a participatory approach in a co-design process, where the teachers and students explored the relationship between space and practice together. As explained previously, the students were most active in the workshops of the co-design process, leaving the teachers to observe, whereas the teachers were the active performers in the process in between the workshops making up new and more creative assignments for the students in order to include the cabinets in the educational practice.

A common denominator in the workshops and the independent process is the participation of the users in the exploration and activation of the space-practice relationship. Based on this, I propose a new concept to be used as a tool in the activation phase, which I call 'participatory activation'. This term includes the active involvement of the participants in the exploration of the potentials of the physical environment in relation to current and future pedagogical practices. In experiments #2 and #3, this was done through the use of co-design, but there are arguably other ways to engage the users in such a process. The important factor, I would claim, is that the activation is participatory, meaning that the users are actively engaged in translating design affordances into practice, as opposed to someone dictating the right way to use the space.

Several times during the interviews, the teachers from school B mentioned a lack of time as a restraining factor. In their experience, they did not have time to experiment with the spatial setting of the classroom under normal circumstances, nor did they have time to experiment with the use of The Wunderkammer cabinet during the co-design process. As explained in the previous chapter, lack of time was also a restraining factor

in school A that kept the teachers from participating in the design process, which influenced the alignment of space and practice. Participatory activation, as presented in experiments #2 and #3, has the potential to 'bypass' this obstacle if it is planned as an in-situ project with teachers and students. In this way, it can become part of the everyday educational activities for a period of time, where the teachers together with the students are guided into recapturing their physical environment and matching space with practice. Thus it will not devour the teachers' time for preparation.

The process of participatory activation is presumed to be an on-going process, because a school design is never totally finished (Bøjer, 2018). Design is ongoing, according to Blackmore et al. (2011), and it constantly develops and transforms with its users, or actors to use Latour's terminology, as it is part of a network of relations.

CHAPTER CONCLUSION

In this chapter, based on three design experiments concerned with the relationship between space and practice, I have argued that the design processes of learning spaces should be participatory and followed by an activation phase in order to create alignment between space and practice. All three experiments have explored different aspects relating to the research program and the main research question of this thesis, which is 'How can participatory design processes and tools inform the interplay between learning space design and pedagogical practice?' The experiments have focused on the design process, the design tools and the design (prototypes), respectively, in an attempt to shed light on the connection between the process of designing learning spaces and the relationship between space and practice. For this reason, each experiment has even explored a subsidiary research question as part of the programmatic design research process in order to inform and 'talk back' to the research program, which has helped create the answers as illustrated in Figure 44.

The research approach has been based on action research and constructive design research, using various design constructions to explore the research inquiry in the three design experiments. In correspondence with action research, these constructions, as physical and processual manifestations of the practitioner activity, have been used as

mediums to explore the research activity.

In experiment #1, the significance of stakeholder participation in the design process in relation to the alignment of learning space and pedagogical practice was explored through a design process of a new innovative learning space in school A. The stakeholders involved in the project were mainly the school management, who were regularly involved in the entire design process, i.e. the initial workshops and repeated meetings, followed by representatives from the municipality who took part in several meetings and the students and parents who participated in workshop #2. The teachers were almost completely missing from the design process. Subsequently, the teachers were unaware of the intentions of the design, did not feel any ownership and did not succeed in matching space and practice. This only started a year later, when the school management took control of the activation of the space. The findings from this experiment indicate that the level of teacher involvement in the design process greatly impacts the alignment of pedagogical practices and learning space design. They also indicate that the interplay and interaction between designer, teacher and school management play a role for the alignment of space and practice. Active engagement by the school management in teacher training in environmental awareness and competence was therefore found to be significant in matching spatial design and use.

Experiment #2 explored how approaches from co-design could inform the interplay between pedagogical practices and learning space design and the transition into new learning spaces through a co-design process in school B. During three co-design workshops and the teachers' independent work with the co-creation cabinets in-between the workshops, two teachers and a fifth grade class explored the relationship between space and practice. The findings from this experiment indicate that the active exploration of space and practice helped increase the teachers' environmental awareness and made them become more attentive to the interdependent relationship. The co-design tools and techniques were found to be a valuable tool in this process as they fostered collaboration and communication in an active and accessible manner that could also potentially help in the process of transitioning into new spaces.

In experiment #3, the significance of spatial activation for the alignment of

learning space design and pedagogical practices was explored through the use of the co-creation cabinets in school A versus school B. In school A, the cabinets were not used due to organisational issues like missing keys and the lack of a common culture of use as well as a lack of knowledge of the intentions behind the design and a missing link between spatial design and practice. In school B, the cabinets were used by the teachers to prototype future practices as they were exploring the potentials of mainly The Studio cabinet. The co-creation cabinet thus became a tool to inform the link between learning space design (in this case both the cabinets and the surrounding space) and pedagogical practice.

Answers:
• Through participatory design processes
• Through participatory activation

Challenge:
How to design physical learning environments that match pedagogical practices?

Program:
Unlocking learning spaces

Sub-Question #3
What is the potential of spatial activation for the alignment of learning space design and pedagogical practices?

Research Question
How can participatory design processes and tools inform the interplay between learning space design and pedagogical practice?

E**X** #3

E**X** #2

E**X** #1

Sub-Question #2
How can approaches from co-design inform the interplay between pedagogical practices and learning space design and the transition into new learning spaces?

Sub-Question #1
What is the significance of stakeholder participation in the design process of new learning spaces for the alignment of space and practice?
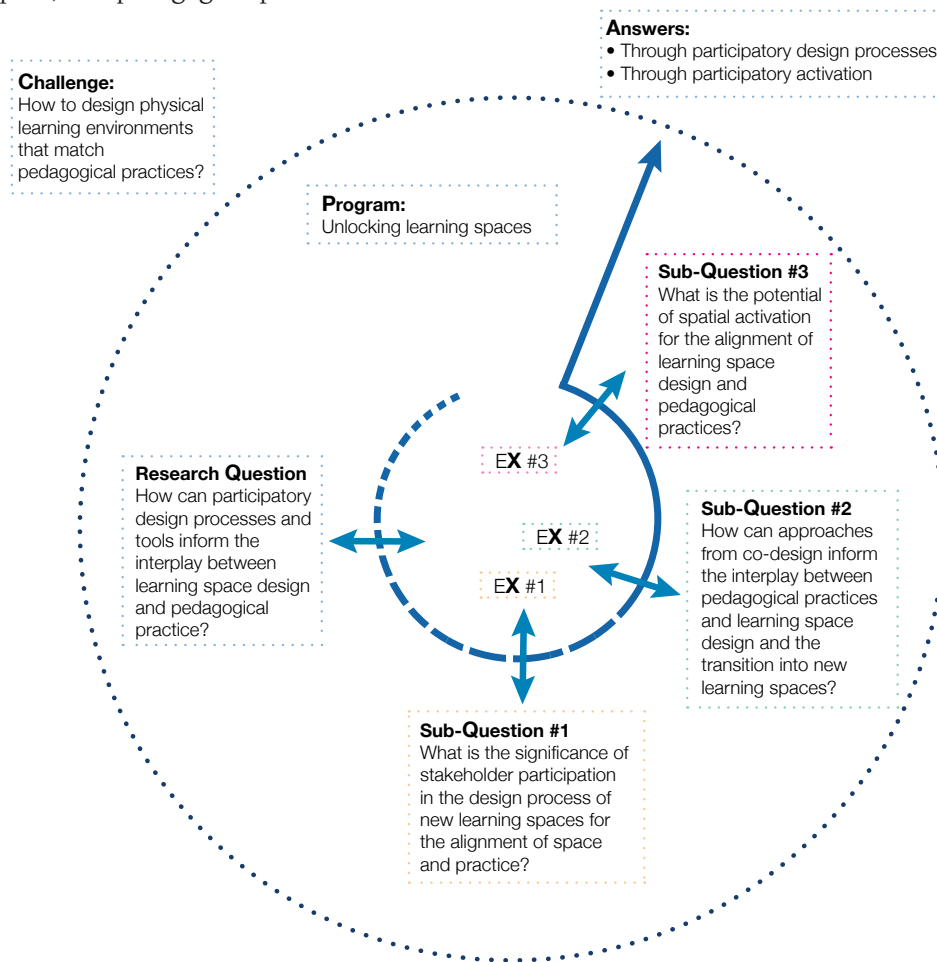
Figure 44. The programmatic approach of my research project set up according to the diagrammatic structure proposed by Bang, 2011—with answers

The results of the three experiments support research literature claiming that user involvement is crucial when designing a new physical learning space and that space and use are interdependent, as explained by Mulcahy et al. (2015) in the following quote:

> *...in a relationalist way of thinking, learning spaces and the uses made of these spaces are created and sustained together; they are in a mutually constitutive relationship. Design can never provide a direct fit between space and occupation, and this space is never simply occupied by people. (Mulcahy et al., 2015, p. 580)*

Designing a new learning space is not sufficient to change practice, but it can help in the process by supporting new and different ways of teaching and learning. However, this change can only happen if the school management and the teachers support the change of practice, which the findings from the three experiments illustrate. This is why participatory activation is important when transitioning into these new learning environments. These claims are supported by the difference in use of the co-creation cabinets in the two schools, where the furniture by itself did not lead to neither use nor pedagogical change. This only happened, when the furniture was included in a participatory process where the use and the design of the learning space were articulated. According to Woolner (2010), the relationship between the user and the environment is dynamic and changeable as it responds to the changes in human abilities, needs and desires. Referring to Martin, she explains how the teachers' abilities to use space will increase through their engaging with design and architecture, which in turn 'will make teachers more confident; more inclined and able to reorganise their classrooms according to their pedagogical intentions, and avoid them being "reduced to defensive postures" in their use of space' (Martin, 2006, as cited in: Woolner, 2010, p. 46). The co-design activities created an easily accessible arena for discussion of the interplay between space and practice, where space was constituted through action. This indicates that the co-design tools and techniques have a potential as tools in participatory activation processes as they actively engaged the participants in exploring their physical surroundings in relation to pedagogical practices.

6 // UNLOCKING LEARNING SPACES—A PARTICIPATORY PROCESS

In the previous chapter, the discussion and knowledge outcome evolved around the three design experiments and how they contribute to the understanding of the relationship between space and practice. The main issues were the significance of the stakeholder involvement in the participatory process as well as the prospects of using co-design to inform the space-practice relationship. In this chapter, the discussions are taken further as the main issues and theoretical framework are discussed in relation to current research and the findings of the experiments. The chapter discusses ANT as a theoretical perspective on the space-practice relationship, reflects on the possibility of using space as a tool in practice and introduces other theoretical models for participatory design processes of learning environments. Furthermore, it discusses co-design as a tool in participatory activation and as a research tool. Last, the choice of methodology and methods and their significance for the research project are evaluated.

FROM A NEW DESIGN TO CHANGED PRACTICE

Change in education is easy to propose, hard to implement and extraordinarily difficult to sustain. (Hargreaves and Fink, 2006, cited in Janssen et al., 2017)

The challenges of designing new learning spaces are captured in this quote by Hargreaves and Fink. As part of my research process, I have visited a vast number of schools in both Europe and Australasia. Many of these were newly built or had gone through a rebuilding process recently, based on visions about 21st century learning skills. In some schools, these visions were materialised in open-plan learning spaces, whereas in others they took the form of smaller classrooms and adjoining breakout spaces shared between several classes. Some of them worked well as teachers had managed to match space with a new pedagogy, whereas in others the teachers struggled a lot as they were 'stuck' in a traditional pedagogy that did not match the design of the new spaces. Through the design experiments performed in this thesis, current research and conversations with teachers, school leaders and other researchers in learning environments, I have come to realise that the schools that 'make it' are the schools that have worked intensely with the transition process and those that continue to work with the relationship between space and practice. This insight is shared with Higgins et al. (2005), who note that the process of user involvement must be continually refreshed and iterated to support ongoing change. Their point is that no design solution will last forever in a constantly changing world (p. 03). Therefore, I propose the concept of 'participatory activation', as presented earlier, to follow a design process of new learning spaces as an additional phase, where designers and users of learning spaces collaboratively activate and match space with practice. I will return to this concept later in this chapter after having reflected on the theoretical framework and the potential of the physical space as a tool for practice.

THE SPACE-PRACTICE RELATIONSHIP FROM AN ANT PERSPECTIVE

The comprehension of space and practice as an interdependent and constant, dynamic interaction, as presented in this thesis, implies that a perfect match between space and practice cannot be guaranteed in advance. As Boys (2011a) points out, it is impossible to design 'a perfect 'fit' between a learning activity and its spaces' (p. 5). Instead, as the findings from the design experiments indicate, space and practice develop through collaborative actions and in relation to various factors—or, to use ANT terminology, in a wide network of actors.

In this thesis, ANT has been used to create an overall scientific theoretical view of the space-practice relationship. Considering learning spaces through an ANT lens has helped me understand the relationship between space and practice as a dynamic network with many different actors that collectively create the learning environment. From this perspective, neither space nor practice can be defined independently, but evolves in relation to the other. ANT has brought attention to the complexity of the relationship between space, practice and a vast range of other elements and actors affecting the relationship. The development of a learning environment is affected not only by the physical layout of the spaces or the pedagogical practices, but also by the design processes, other stakeholders, the educational culture, teachers' environmental awareness and competence, budgets, school organisation, students etc. as demonstrated by the design experiments. As a response to this, I propose that more focus and resources should be provided to stakeholder participation in the design process to account for some of these influential factors and through this create a basis for the alignment of space and practice.

ANT, in particular Latour (2005), has even helped shed light on the role of design in the space-practice relationship as it accentuates the significance of the non-human element in the network of relations between surroundings and the user. This became evident in experiment #3, where the co-creation cabinets provided new affordances for the teachers in school B. From an ANT perspective, the co-creation cabinets were 'made to act' by the students and teachers, but at the same time they also made the

students and teachers act by providing new possibilities for practice. As designers, we had designed them with an intention, a specific 'program of action' (Kirkeby, 2006, pp. 145-146), aiming to support certain actions and activities. As such, they were assigned a role as mediators between designer (intention) and user (use). Latour (2005) explains that 'in addition to 'determining' and serving as a 'backdrop for human action', things might authorize, allow, afford, encourage, permit, suggest, influence, block, render possible, forbid, and so on' (p. 72), which is similar to the definition of the concept of affordance by Gibson (1979). In this sense, the affordances of a spatial design are not fixed but relational to the other actors.

According to Latour (2005), the question to ask when looking at actors (or agents, as he calls them in this context) in networks are: 'Does it make a difference in the course of some other agent's action or not?' (p. 71). As mentioned previously, the co-design process with workshops and activities in experiment #2 as well as the co-creation cabinets in experiment #3 changed the action of the students and teachers in school B. They changed the use of the classroom and the pedagogical practices as they supported and pushed the class into using their physical surroundings differently and doing other assignments. The co-design activities also made a difference in the use of the co-creation cabinets. The users even found alternative ways to use the cabinets, e.g. as a place to eat their lunch, and through this they changed the actions of the cabinets. In contrast to this, the co-creation cabinets did not change the actions of the teachers in school A—because they were not used at all.

Considering learning spaces from an ANT perspective also implies that a design is never finished, but constantly evolves and changes in relation to its users and other actors. The users will change the space and the space will change the use and the users, cf. the above-mentioned statement. From this perspective, the space is regarded as an actor in an actor-network relationship that needs to be activated by the users, just as practice can be activated by the design of the space, as presented earlier in regard to the co-creation cabinets. In reality though, these interactions often only cause minor changes to the physical space because people rarely move furniture once it has been placed in a space (Rivlin & Wolfe, 1985). This calls for more attention to the possibilities of spatial activation and development of what Martin (2002) and Lackney

(2008) describe as environmental competence.

Based on the research of this PhD project, I will argue that the view of space and practice as relational and interdependent is very important in the process of designing new learning spaces in order to create a better match between the spatial setting and the educational activities. To substantiate this point, I refer to Cleveland (2011), whose research reveals that the effectiveness of innovative learning environments primarily depend on how well particular pedagogical practices, social factors and school organisation (e.g. curricula) are supported by and aligned with the physical environment. Considering space and practice as an interplay also brings attention to the importance of stakeholder involvement in the design process to create alignment between the various elements that jointly create a learning environment.

As a critical comment to ANT in relation to learning space design, I would claim that ANT can be experienced as trivialising the world and diminishing the role of the designer and the intention of the design. From an ANT perspective, there is no hierarchy in the relationship between humans and non-humans and the network structure between the elements of a learning environment is therefore completely flat. However, research presented in this thesis has shown that the layout of a learning space can be intended for one or more specific pedagogical purposes, thereby supporting some activities better than others. This is designed into the space by the designer. At the risk of contradicting myself, I will therefore argue that the learning environment network is not 100% flat.

LEARNING SPACES
—A TOOL FOR PEDAGOGICAL PRACTICES

If a new spatial design cannot change practice, then why do we redesign so many schools today based on new pedagogical visions? Although current research shows that space does not automatically change practice, it also indicates that the design of the space has an impact on practice and learning outcomes (Byers et al., 2014; Cleveland, 2011). This leads me to the argument that the design of the learning space can become a tool to support pedagogical practices. As proposed previously, a learning space will have

certain physical qualities based on its physical design. These qualities, or affordances to use Gibson (1979), can support or hinder different types of actions. The affordances of open plan learning spaces as well as closed classrooms will be experienced differently and provide different possibilities for individual users as they are relational to the individual. Looking at space as a tool implies that we understand space as designed with a specific intention (or multiple intentions), a built pedagogy, which determines its qualities. That does not mean, however, that the intentions and qualities determine the use. The space can still be used in other ways than intended, which the first experiment of this research project substantiated. Just like a screwdriver, designed with the specific purpose to turn screws in or out of something, can be used for other purposes such as opening a bucket of paint or a cap on a bottle, so can a learning space design. The design of the space does not prevent the user from using the space against its intentions; however it might make practice more difficult as proposed by Monahan (2002). This shows that the relationship between design intention and the use of the tool (screwdriver or learning space) is dynamic and dependent on both the design of the tool and the user. Therefore, I propose that an alignment of space and practice should be sought after, not as a fixed and absolute relationship but as a dynamic and constantly evolving interplay. It is in this perspective that I suggest both wider stakeholder involvement in the design process and a participatory process of activation after the implementation of the final design.

EXPLORING PARTICIPATORY DESIGN PROCESSES—EASY TO PLAN, DIFFICULT TO CONDUCT

As the first experiment of this thesis illustrates, it can be a complicated affair to conduct a design process when it comes to involving the stakeholders, in particular the end users. For this reason, researchers are currently exploring what they call 'participatory building design' (e.g. Könings et al., 2017) and proposing different models and tools to structure participatory design processes and conduct user involvement. Still, according to Janssen et al. (2017), the development of the models to effectively

engage non-designers in design activities of participatory educational design is in its early stages. A small selection of models to facilitate the involvement of stakeholders in the design process of both instructional and physical learning environments is presented in the thematic issue '*Participatory Design of (Built) Learning Environments*' (Könings & McKenney, 2017), which I referred to in chapters 2 and 3. The models all attempt to provide transparency, clarity and guidance in order to enable participation of stakeholders in educational building projects, according to Nordquist and Watter (2017), but they are mainly conceptual and especially focused on the early pre-design phases of a design process.

In the following, I will briefly introduce these models to present other approaches to participatory design processes in educational design. These models are all presented in a magazine from late 2017, which explains why they have not been used (or considered) in my first design experiment (it took place from Nov 2016 until May 2017). Instead, I used the design process model in Figure 27 on page 163. The models have not influenced the other experiments, which were not connected to an actual design process but explored the potential of participatory tools to create discussions and awareness about the relationship between space and practice in a post-design phase. Had I used one of these models, for instance the 4C/ID by van Merriënboer et al. (2017), the design process might have looked different. However, I consider that some of the limitations in experiment #1, e.g. time pressure and budget limitations, would not have been altered by the models and thus, the alignment of space and practice would still have been compromised.

The participatory design models presented in the following aim to facilitate the involvement of stakeholders in the design process, in particular in the early pre-design phases, based on a variety of tools: (1) the 'laddering tool' and the 'building block tool' (Janssen et al., 2017); (2) the 'building interaction modelling' (BIM) tool, a technology-based visual information tool (Koutamanis et al., 2017); (3) an interdisciplinary model of participatory building design in education (Könings & McKenney, 2017) and (4) a theoretical four-component instructional design model (4C/ID) (van Merriënboer et al., 2017).

Janssen et al. (2017) propose two theory-based tools, the 'laddering tool' and

the 'building block tool', respectively, to facilitate the collaborative processes of educational approaches and physical learning spaces. Whereas the laddering tool was developed to support participants in mapping and sharing their multiple goals, the building block tool was developed to help participants explore practical and effective possibilities. Both tools are meant for use in design processes to improve the quality and usability of instructional and physical learning environments. They mainly address the instructional learning environments, helping teachers to explore teaching goals and generate new ideas for teaching, but indirectly they also facilitate the design of supportive physical environments by helping the teacher discuss their practice. However, as Janssen et al. (2017) conclude, these tools are limiting when it comes to addressing the physical learning spaces and complimentary modular tools are therefore needed to guide the design of classroom environments more directly.

Koutamanis et al. (2017) suggest a technology-based visual information tool, the 'building interaction modelling (BIM) tool', as a means to create better communication between constructors and users of the school buildings. BIM was originally used in the interaction between designers, architects, engineers and consultants, but Koutamanis et al. suggest that the tool can also be used to support managers, teachers and students in participating in the design of their school building. This is believed to improve the alignment of educational goals, policy and the built learning environment (Koutamanis et al., 2017). However, the proposal is a conceptual experiment and has not been tried out in practice.

Könings et al. (2017) have developed 'a new interdisciplinary model of participatory building design in education' that addresses (re)design of both physical environments and instructional methods (p. 306). The model combines input from a workshop with 16 architects, educational designers, teachers and students on participatory processes and stakeholder involvement as well as existing models for validating and informing participatory building design. These models are:
- the Action Research Cycle (a cyclical model with distinct stages of planning goals, implementation, observation and reflection, based om Zuber-Skerritt's (1992) model of action research);
- the Stakeholder Analysis Model (a common tool that can be used in participatory

building design to decide whom to involve);

- the Ladder/Climbing Frame of Participation (a model based on Arnstein's (1969) 'ladder of participation', which presents different levels of citizen participation, and Singer and Woolner's (2015) 'climbing frame' model which illustrates the multidimensional nature of participation);
- the Participation Matrix (a model which captures the appropriate level of participation of various stakeholder groups in different project stages).

The aim of the new model, presented in Figure 45, is to provide a tool for educational practice in co-designing physical learning environments (Könings et al., 2017). As with the other tools presented here, the Interdisciplinary Model of Participatory Building Design is conceptual and has not been tested on a real building design process.

Plan

Cycle 1	Inform	Consult	Partnership	Control
Planning		E	S, T, A	
Implementation		E	S, T	A
Observation		E	S, T, A	
Reflection		E	S, T, A	

Experiment

Cycle 2	Inform	Consult	Partnership	Control
Planning			S, T, A, E	
Implementation			S, T, E	A
Observation			S, T, A, E	
Reflection			S, T, A, E	

Realise

Cycle 3	Inform	Consult	Partnership	Control
Planning			S, T, E	A
Implementation		S, T	E	A
Observation			S, T, E	A
Reflection			S, T, A, E	

Use

Cycle 4	Inform	Consult	Partnership	Control
Planning		A	E	S, T
Implementation		A	E	S, T
Observation		A	E	S, T
Reflection		A	E	S, T

Figure 45. Interdisciplinary model of participatory building design by Könings et al. 2017. S = Students; T = Teachers; A = Architect; E = Educationalists—presented here as an example of a model for participatory designing of learning environments

A different approach is initiated by Van Merriënboer, McKenney, Cullinan and Heuer (2017). They suggest a three-phased participatory design process model, ranging from idea to design development and finally realisation, that aims to align pedagogy and physical spaces in the design of new school buildings. In the first phase, a theoretical

four-component instructional design model (4C/ID) addressing four basic educational components is used to specify the pedagogy. In the second phase, physical seating arrangements and physical spaces are developed (conceptually) and matched with the pedagogical activities defined in the first phase. In the third phase, the school building is realised. The process is envisioned to be iterative with different stakeholders involved at different stages of the process until the building has been realised (van Merriënboer et al., 2017). As such, it resembles a 'traditional' participatory design process with the main difference being the 4C/ID model in the first phase. The model offers a generic approach to the design process to support the alignment of pedagogical vision and enactment as there, according to van Merriënboer et al. (2017), 'is a clear need for an integrative design approach that helps to reach an optimal alignment of pedagogies and the physical environment' (p. 265). However, van Merriënboer et al. only recommend the model for new building projects. The reason is that existing classrooms are much more challenging because of their legacy than new learning spaces and more research is therefore requested to render the model suitable for redesign projects (van Merriënboer et al., 2017).

According to Janssen et al. (2017), there is a need for participatory tools and models which allow multiple stakeholders with different backgrounds and expertise to become acquainted with each other's context and goals and to co-design and choose alternatives in participatory design processes. A common denominator for the models presented here is that they are mainly conceptual and that hardly any testing has been conducted in practice. Neither do they suggest actual tools or methods for use in participatory design processes. For these reasons, more research on each model, as well as alternative approaches, is needed. Moreover, several of the tools presented here focus more on the instructional environment and less on the physical spaces.

PARTICIPATORY ACTIVATION AS A MEDIATOR BETWEEN SPACE AND PRACTICE

In 2017 I attended a conference about Educational Architecture in Copenhagen, where Julie Willis, professor in architecture, stated, 'Schools don't stand still, they reuse and change space all the time'. Her statement substantiates the assumptions in this thesis that learning spaces are part of a dynamic relationship and thus should not be viewed as static designs. Higgins et al. (2005) emphasise that participatory design processes of learning spaces needs to continue throughout all phases, from design to evaluation, in order to obtain a lasting impact within the rapidly changing context of today's world. As I argued in the previous chapter, participatory design processes that come to a halt as soon as the last design feature has been implemented in the learning space are not sufficient to really inform the relationship between space and practice. Neither would it be enough to evaluate the space afterwards unless this evaluation is combined with or followed by a process of activation, especially in case of a disharmony in the space-practice relationship.

As suggested previously, an additional phase should be added to design processes of learning spaces to support the ongoing alignment of space and practice. In this phase, I propose that the users of learning spaces work together with design professionals in a process of participatory activation, which can be explained as an ongoing process where space and practice are explored and matched through various participatory activities.

Returning to the mediation model adapted from Kirkeby (2006), the participatory process takes place in between space and practice as a constant and never-ending interaction. If we assume that space and practice are actors in a complex and ever-changing network, as ANT would contend, they need to be activated by other actors in an ongoing and dynamic process. This interaction takes place between space and practice as a constant translation and transformation of the spatial layout and practices, as illustrated by the arrows in Figure 46. To ameliorate this process of participatory activation, I propose co-design tools and techniques as an activating actor as demonstrated in experiment #2. I will return to this in the following sections.

INTENTION > PROGRAM > DESIGN > SPACE < ACTIVATION > PRACTICE

Figure 46. Mediation model with 'participatory activation' as a two-way mediation between space and practice

CO-DESIGN—A TOOL FOR PARTICIPATORY ACTIVATION AND A MEANS TO ENHANCE ENVIRONMENTAL AWARENESS AND COMPETENCE

As explained earlier, co-designing mostly happens in the predesign phase of design processes to establish a common platform from where the design can evolve (Sanders, 2013). Currently though, a rising interest in design after design has been detected by e.g. Lundsgaard (2011). Design after design has also been a growing focus in this research project. Through the design experiments, I have explored how the co-design process can be extended to handle the transition into and appropriation of a new learning space by fostering reflections, explorations and discussions concerning the relationship between space and practice. Based on the findings from these experiments, I suggest that co-design can help develop teacher environmental awareness and competence because it allows for testing and exploration of the actual space-practice relationship and initiates imaginations on possible future spatial layouts. This, in turn, will contribute to the alignment of space and practice as environmental awareness and competence are believed to help teachers see and utilise the affordances of the spaces in relation to their practices (Lackney, 2008; Martin, 2002). Environmental competence, in particular, is highlighted as important by Martin (2002), who claims that, by increasing their environmental competence, teachers will become more confident and inclined to reorganise their learning spaces according to their pedagogical intentions (as cited in: Woolner, 2010, p. 46). She distinguishes between awareness and competence, asserting that only the latter will allow the teachers to actively use and redesign the space.

The second design experiment substantiated Martin's assertion. At first, the co-

design process did not appear to enhance the environmental awareness of the teachers in school B significantly, as they, according to their own statements, already thought a lot about space in relation to everyday practice. However, as both my observations and the interviews illustrated, the teachers did not actually use this awareness to redesign their spaces to fit practice. During the interviews following the co-design process, the teachers explained that they had felt restrained in exploring different spatial settings for several reasons such as lack of confidence, time limitations and shared spaces. This, I would argue, supports Martin's point about environmental awareness and competence. Even though teachers are aware of the potential of the space in relation to practice, they might not have the competence or feel confident to actually reorganise and redesign it. Following the co-design process, the teachers in school B expressed a desire to experiment with the physical surroundings, which indicates that the co-design process and tools helped them become more confident to alter the spatial configurations, thereby enhancing their environmental competence— at least initially. Whether or not the process has left a lasting mark on their practices is yet to be researched.

Still, I suggest that co-design has the potential to become an important tool in the post-design phase (the transition phase as well as the consolidation phase) as a means to enhance the environmental competence of the users. As elaborated, the tools and techniques of co-design were found to support the process of participatory activation and therefore the co-design approach potentially contributes to a better alignment between space and practice.

The process of participatory activation is proposed to take place continuously because a learning space design is never really finished but keeps evolving with its use and its users. The school is a dynamic environment with a shifting group of users with a wide spectrum of needs and visions. New users might not be familiar with the original intentions behind the design or have the environmental competence to alter the spatial setting to match their practices. Therefore, space should not be seen as a static design, but as ongoing, open, relational and constantly developing and transforming with its users (Blackmore et al., 2011). This is what participatory activation aims at: to continuously and iteratively involve the users in the process of aligning space and

practice.

I do not claim that co-design is the only approach to activating learning spaces, nor that co-design can stand alone as a method for activation. All spaces and people are different. Activation can potentially take place in many ways using many methods and as such the matter needs more research. In this thesis, I propose co-design as one potential approach to actively engage the users in explorations of the space-practice relationship due to its many tools and possibilities. Each co-design process has to be designed for its specific purpose and participants (Sanders et al., 2010a) and as such can be used in very different projects and with many different people. The variety in tools and techniques helps establish an arena for discussions on a particular issue, in this case learning spaces. Therefore, co-design can help enhance the environmental awareness and competence of the teachers which, in turn, will inform the relationship between space and practice and help the teachers make better use of their learning spaces. Finally, this will be of benefit to the students.

THE POTENTIAL OF CO-DESIGN AS A RESEARCH TOOL

The use of participatory tools to engage users in school design is not a new approach in design practice, whereas research into education, according to Woolner et al. (2010), is constrained by a dependence on language. However, Woolner et al. (2010) claim, visual and spatial methods are needed to develop an appropriate understanding of the learning environment. The reason for this is that visual and spatial material can widen participation to include all users, which makes it particularly appropriate for examining the contribution of the spatial layout to the learning environment (Woolner et al., 2010, p. 4). This was also my experience in this research project, where co-design was found to provide a way of facilitating discussions about abstract pedagogical philosophical issues on an all-inclusive level. Through the visual and hands-on activities, teachers and students were able to participate in the explorations of their space and practice on an equal level and exchange meanings on abstract subjects like learning in a very concrete manner (see chapter 5 for detailed information on the co-design activities

and their potentials). As such, co-design was found to be a valuable research tool as part of a constructive design research approach.

During my literature research, I only discovered few other studies exploring actual participatory methods for engaging the users in school design processes. One of these studies was performed by Woolner et al. (2010), who examined three types of visual and spatial methods—photo elicitation, diamond ranking (Clark, 2012) and map-based activities in an empirical study in a school. Overall, the visual and spatial methods were found to facilitate the engagement of a wide range of stakeholders by provoking and focusing immediate discussions and mediate between participant and researcher. The various activities complemented each other and the results were found to construct information relevant to the particular school involved in the project. Furthermore, they were experienced as potential tools for other educational researchers. However, as Woolner et al. (2010) conclude,

> ...if this methodological opportunity is to be fully exploited to improve our understanding of learning environments, it is important that researchers go beyond the fairly familiar ground of photo elicitation. As this project demonstrates, straightforward photo elicitation might be able to tell us what is happening in a context, but it is necessary to use a range of visual and spatial methods to understand, in addition, where and to what extent things occur and to begin to suggest why. (2010, p. 21)

Responding to this call from Woolner et al. (2010), I have explored a participatory approach to understanding the relationship between learning space design and pedagogical practices by using a wide range of visual and hands-on co-design tools. In collaboration with traditional research methods such as interviews and observations, these tools have provided a multi-methods approach similar to the 'mosaic approach' developed by Clark (2005) as a way to engage young children in research processes. The mosaic approach likewise combines traditional methods with participatory tools in order to be able to facilitate exchange of meanings between children, practitioners, parents and researchers. The multi-methods approach, as used by Clark (2005) and in

this research project, allows for a wide and diverse collection of data and individually and creatively designed research activities that can help inform the research project. Conversely, the diversity in data poses a challenge to the design researcher as there is no simple model or system to follow in the analysis of the data. For this reason, I developed the learning environment triangle, which will be discussed in the following section. Furthermore, I used current research literature to substantiate the research findings.

The use of co-design in this research project differs from other research projects in learning space design as the project uses co-design tools as a research tool and also as a means to activate the space-practice relationship. Both were found to be of great value to the project.

REFLECTIONS ON THE METHODOLOGY AND METHODS

In this thesis, the space-practice relationship has been examined using a constructive design research approach with actual design experiments and design constructions as the empirical material in a programmatic framework. The research has been conducted as action research, taking place in a local context in two schools. The design constructions (design processes, design tools and design prototypes respectively) have played the central role in the research project as they have been used to gather knowledge through interventions in real-life contexts. This constructive and action-based research approach has provided me with the possibility to actively test assumptions in actual learning environments and with 'real' users while remaining open to new perspectives and insights.

The co-creation cabinets and the co-design processes were designed to generate knowledge and were thus used as research tools rather than being 'just' design objects and a process of creating new designs. This is a common approach in constructive design research, where design constructions (also called prototypes) can have different roles in the generation of knowledge (Wensveen, 2018). They can, for instance, act as a physical hypothesis that can be tested or as a means of inquiry. The latter implies

that the prototypes are used as a tool to collect, record and measure phenomena, i.e. in a context of use or to create a situation or circumstance for the purpose of analysis (Wensveen, 2018). This is also the way the design constructions were used in my project—as a means of inquiry.

The constructive and programmatic research approaches were found to provide a valuable methodological framework for my research. As a design researcher, I have tried to keep an open mind to the experiments and their 'talk back' to the overall program, which has led to both findings and drifting of the program as explained in chapters 4 and 5. In the first design experiment, the project took another direction than expected as it developed, which caused the program to drift. Focus changed from design process to participatory activation and, as such, the experiment developed the research program and project.

At the same time, the constructive design research approach has also posed a challenge in this study. The project includes ample data collected through various qualitative methods, which makes the empirical material quite fragmental and widespread. As described earlier in this thesis, the research methods in constructive design research include both traditional methods like observations and interviews, as well as generative research methods that put design practice at the core of the research such as collages, mood boards, storyboards, scenarios, personas, design games, prototypes and various types of role-playing (Koskinen et al., 2011). The possibilities therefore seem endless when it comes to research methods in constructive design research, which might be experienced as a strength but also as a weakness. In this research project, co-design was chosen as the specific research approach as it offers fairly concrete and well-defined tools by e.g. Sanders and Stappers (2014) and Sanders et al. (2010a), which I supplemented with qualitative methods such as observations and semi-structured interviews. Otherwise, the multiple possibilities in research methods in constructive design research might have been experienced as problematic, in particular since current literature does not provide much information on how to bridge between and analyse the data collected through these methods. Similar observations concerning the lack of tools for 'handling and bridging between the actual detailed methods and techniques in processes of constructive design

research' are stated by Bang et al. (2012, p. 3) as a critique to Koskinen et al. (2011). I have found the lack of information on how to handle data to be a general problem in design research as I have come across scant literature on how to analyse data collected through practice-based design research. This might be connected to the expansive and very broad field of constructive design research projects, but I still suggest more research to be conducted on this subject.

In general, the concept of practice-based design research still seems to provide a partly open playground for the researcher to explore and navigate in. This may be seen as a strength, as it opens up for many different project types and directions, but also as a weakness, maybe especially in comparison with the more traditional scientific research traditions with their relatively structured and well-proven research paths. In this research project I have experienced the combination of co-design tools and more traditional qualitative research methods such as interviews and observation to be a valuable combination. It provided a breadth in the data, which has helped enlighten the research inquiry and issues from multiple angles.
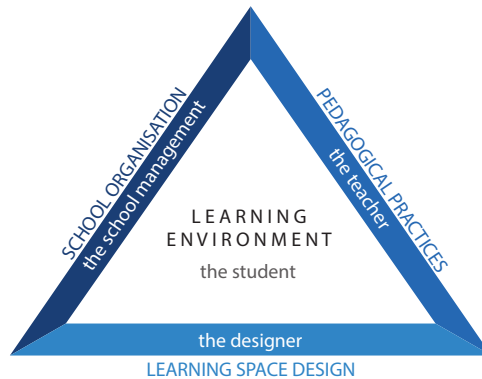
Figure 47. The learning environment triangle

For the analysis of the design experiments, I developed the learning environment triangle (Figure 47), which had multiple functions. On a theoretical level, the triangle visualised the network of a learning environment (in a very simplified version) and as such relates to the overall scientific theoretical perspective, ANT, and on a more practical level the triangle has worked as a framework through which I have

structured and analysed the complex and widespread data material collected in the three experiments. The model has its limitations due to e.g. its simplified structure and specific focus on space, practice and organisation, which entails that it cannot provide exhaustive knowledge on all aspects of the space-practice relationship in learning environments. Still, I have found it to be an applicable tool in relation to the constructive design research approach in my research project.

THE CHOICE OF DESIGN THEORY AND METHODS

In order to properly explain and explore the design research field in which this research project is positioned, I have chosen to describe and include a broad selection of theories and perspectives. Together, these theories and perspective constitute the field of practice-oriented design studies. On the pro side, this illustrates the multiple possibilities in design research and practice and contributes to an openness in a field defined by multi-perspective insights and approaches—much in accordance with the open, explorative and process-oriented nature of the design discipline. In design, there is not one correct method or way to do things but many possibilities. I regard this to be the strength of the discipline.

This approach, on the other hand, can be criticised for keeping the thesis 'too close to the surface'. The broad selection of theories and methods keeps the project from going into depth with just one or a few of the methods and their potentials and limitations in learning space design research. This, however, is a deliberate choice based on the previous explanation and the time frame of this PhD project. In future research projects, the relationship between space and practice could be explored using mainly one method, e.g. co-design, as a research frame.

CHALLENGES AND CRITERIA IN A QUALITATIVE RESEARCH PROJECT

In correspondence with the constructive design research approach, this project has been conducted as a qualitative study. Earlier, I have addressed some of the challenges I have experienced in relation to the qualitative research approach, however, in the following I will try to elaborate on these in relation to a selection of criteria proposed by Tanggaard and Brinkmann (2015c) and Robson (2011).

According to Tanggaard and Brinkmann (2015c), the broad variety in qualitative studies means that it is difficult to outline a common set of quality standards applicable across all qualitative studies. Most importantly, Tanggaard and Brinkmann claim, the qualitative research should be valued based on its own quality criteria and not on the criteria of a quantitative research tradition. In response to this, they present numerous criteria by different qualitative researchers and emphasise in particular qualities such as transparency, recognisability, credibility and the degree of methodological reflection by the researcher.

Throughout this thesis, I have pursued to present the design and conduct of my research in a detailed and transparent manner that would be easy for the reader to follow. As part of this, I have included several quotes from the interviews and email correspondences with the participants in the design experiments. Including examples is, according to Tanggaard and Brinkmann, a way to illustrate the analytical procedure and the understanding obtained through the analysis. I have also tried to be clear about my theoretical perspective as well as my personal expectations to the research, which is another criterium presented by Tanggaard and Brinkman. My research design and process have been based on and continuously related to current research and theory and I have sought to maintain an open and exploratory approach in the design experiments.

Using extreme cases, following surprises and looking for negative evidence are, according to Robson (2011), other criteria in qualitative research. In particular the findings from the first design experiments were unexpected and surprising as well as negative in relation to the initial program of the research, which I pursued and used to

develop the second and third experiments.

According to Robson, the researcher effect is yet another thing to consider in qualitative research, which implies that the researcher can influence the case (in this project, the design experiments) and the case can influence the researcher. As touched upon earlier, my dual role as both a researcher and a practitioner in the research process has been a challenge which I have continuously sought to balance. My close involvement with the designers at Rune Fjord Studio and my interventions and collaborations with the participants in the design experiments have influenced the research process and potentially the results. However, this is an unavoidable aspect of constructive design research performed in a field-setting. To account for this, I have aligned and substantiated the findings from the experiments with current literature. I am also aware that I, when analysing the data, have sought for certain patterns and connections based on the learning environment triangle, which might have omitted other factors of the space-practice relationship. Furthermore, my association with Rune Fjord Studio, a commercial company, can be questioned as biasing for the research results. However, as underlined earlier, I have continuously sought to account for this by being aware of the dilemma and open to the experiments as well as by relating findings to current literature.

Finally, I am also aware that the design experiments, due to the limitations in scope, are neither exhaustive nor necessarily representative for the interplay between learning space design and pedagogical practices. Instead, they are examples of 'the art of the possible' and point towards various dilemmas and possibilities in relation to the design of learning spaces.

7 // CONCLUSION

This thesis has explored and discussed design processes and design methods in relation to the design of learning spaces. The main focus has been the significance and potential of using participatory design processes and methods to inform the interplay between learning space design and pedagogical practice. The overall theoretical framework has drawn on ANT and current learning space research from a relationalist perspective. The empirical research has been conducted as design experiments exploring design processes and design methods in a participatory context in two schools. Subsequently, the findings from the experiments have been substantiated and challenged by existing research focusing on the design of learning spaces. This final chapter contains the conclusion of my three-year long Industrial PhD project and outlines the contributions presented in this thesis. It also reflects on the limitations of the research project. Last, the chapter offers perspectives for future initiatives, suggesting that more research should be conducted concerning the potential of design methods in design processes and activation processes of new learning spaces.

CONCLUDING REMARKS

I started this thesis by asserting that space does not change practice, people do. However, I also proposed that the spatial layout could make a difference for practice by either supporting or obstructing certain activities. Based on the findings from the three design experiments presented in this thesis as well as existing literature, I maintain this assertion.

The first design experiment of this research project demonstrated that the implementation of a new learning space design does not automatically lead to a change in pedagogical practices. In spite of the intentions, the new learning space in school A was designed and implemented with little user involvement due to limitations in building budgets and teacher time, amongst other things, and was subsequently used contrary to its spatial affordances. This resulted in the design being experienced as an obstacle rather than an asset to practice. It was only when the school management started directing the use of the space and thus contributing to a development of teacher environmental awareness and competence that an alignment of space and practice was initiated. Thus, the findings from the experiment indicate that the level and the extent of stakeholder involvement, in particular the end users, in the design processes of new learning spaces strongly impact the subsequent alignment of space and practice. They also suggest that a new spatial design has to be activated and matched with practice through the development of teacher environmental awareness and competence.

In response to this, I suggested the concept of participatory activation as part of or following a design process, which implies that designers and users of learning spaces collaboratively activate and match space with practice. This was partly tested in the second design experiment, where a co-design process was conducted with a fifth grade class and two teachers in school B. The co-design tools and techniques were found to positively inform the interplay and alignment of space and practice as they initiated collaborative discussion and activation of the spatial design and therefore supported the development of teacher environmental awareness and competence.

In the third design experiment, the use of two co-creation cabinets designed as part of this research project was explored in school A and school B. The use was subsequently compared and discussed in relation to participatory activation. In school

A the cabinets were unused, whereas in school B the cabinets worked as a change agent in regard to matching space and practice. However, this was closely connected to the co-design workshops and as such part of a process of participatory activation. This substantiates the assumption stated in the beginning of and continuously throughout this thesis that space and practice are interrelated and mutually affect each other in a dynamic and ongoing interplay. It also substantiates the need for participatory activation of learning spaces.

My conclusion is that changing space without involving the users in the design process is unlikely to change practice. Still, a new space can become a catalyst for change, provided the users are involved in the design process and take part in a subsequent phase of participatory activation. This implies that the alignment of space and practice should be regarded as a dynamic and ongoing collaborative process that needs to be considered and revised before, during and after the implementation of a new learning space design. This process not only involves the teachers and designers, but even the management of the school. During the regular design process, the designers, teachers and school management can work with the alignment of space and practice in co-design activities by discussing and exploring future space-practice scenarios. In the additional design phase, the Delivery & Activation phase, this explorative process can continue with participatory activation of the actual learning space in relation to practice—preferably as an in-situ project with teachers and students. Thus, as proposed earlier, the teachers are guided into recapturing their physical environment and matching space and practice in collaboration with the students, which bypasses organisational issues such as restricted time for preparation or budgets.

Therefore, I propose that school building projects would benefit from both extensive user involvement in the design processes of new types of learning environments and a subsequent phase of participatory activation of the new spaces in relation to practice. This would help develop teacher environmental awareness and competence and a better alignment of space and practice could be obtained. This is not a matter of teaching the teachers how to use the space, but a way of collaboratively working with design and practice to change teacher mindsets, enhance environmental awareness and competence and align space, organisation and practice. Students are likewise

believed to benefit from participatory activation as they become more conscious about and take part in controlling their own learning situations. This is, however, another subject and another research project.

Based on the findings from the design experiments, I suggest co-design as a tool in participatory design processes and participatory activation of new learning spaces. In this research project, co-design was found to be a key to unlocking the space-practice relationship due to its ability to engage the participants in actively exploring and discussing both current and future spaces and practices. This answers the overall research question of how participatory design processes and tools can inform the interplay between learning space design and pedagogical practice—by creating a dynamic and explorative connection between design and user both during a participatory design process and through participatory activation.

RESEARCH CONTRIBUTIONS TO CURRENT RESEARCH AND PRACTICE

This research project was conducted as part of an industrial-academic collaboration, and as such it has aimed to create knowledge of both a theoretical and practical character in order to inform both research and practice.

The research presented in this thesis 'talks into' a cross-disciplinary research field of education, architecture and design, where most research emanates from the field of education. Building on a design perspective and using a practice-based design research approach distinguishes this project from most other research projects with a space-practice focus on learning spaces. As such, the thesis aims to add a brick to a new bridge connecting the research fields of education, architecture and design on the research topic of learning space design.

Through the design experiments, the project demonstrates that a new spatial design does not change practice as this is highly dependent on the users. However, the spatial design (the co-creation cabinets) was found to be both a catalyst in the process of change and a supportive tool for particular activities when included in a collaborative design process.

The thesis does not provide solutions and guidelines on how to conduct design processes in future building projects of new learning spaces, nor does it provide a fixed toolkit for activation processes in finished learning space designs. Instead, its goal has been to bring attention to the significance of a participatory approach in the design and appropriation of learning spaces and to open up for a new research area, where design methods are explored as means to developing environmental competence and inform the relationship between space and practice. The project provides knowledge on the nature of the interplay between space and practice and thus, despite building on praxis, its contribution to the overall research field is just as much on a knowledge level as on a practical level.

I consider the outcome of this research project as a contribution to research in learning space design, design research and design practice. In the following, I introduce the research contributions and how they address the three areas.

Research in learning space design

As mentioned earlier, most research on learning spaces comes from education, whereas this research project builds on a design perspective and uses a practice-based design research approach. In this, I hope to pave the way for more research on learning space design coming from the fields of design and architecture with design practice as the focal point. My project provides an example of how practice-based design research can be used to enlighten the space-practice relationship, which in this case is done by actively engaging in experiments in-situ in a participatory context. Thus, the project emphasises the significance of also exploring research inquiries concerning learning spaces in real contexts and through a practice-based approach as this might enlighten other issues and perspectives.

The research project addresses a gap in current research concerning the transition and consolidation phases of new learning space, which has been emphasised by Blackmore et al. (2011). Through the experiments, I demonstrate how space and practice are interdependent and how the use of a learning space is connected to the involvement (or lack of involvement) of the end users in the design process of a new learning space. Furthermore, I demonstrate how co-design tools can contribute to

informing the interplay between space and practice by enhancing the environmental competence of the teachers. It is my hope that this knowledge will contribute to the development of future design processes of learning spaces and open up for a new research area, where design methods are explored further as means to informing the relationship between space and practice.

Design research

Additionally, the project contributes especially to the field of design research by exploring design processes, co-design and constructive and programmatic design research as tools for both research and for post-design learning space activation in a participatory context. The project draws on the tradition and theories of participatory design and constructive and programmatic design research in the experiments, where co-design tools and techniques are explored as means to informing the space-practice relationship. Focusing especially on the possibilities of co-design in a post-design phase of a learning space design process, the project provides new knowledge on design after design. The thesis suggests that co-design can provide tools for user involvement, not only during the design process but even after, in a post-design participatory activation phase of leaning spaces. In this it addresses research in both learning space design and research through and on design practice.

Design practice

Finally, the research project contributes to the ongoing discourse and methodology within the design and architectural professions engaged in the design of learning spaces. Overall, the thesis calls for an increased focus on stakeholders and end users in the process of designing learning spaces, suggesting that this will improve the relationship between space and practice in new or rebuilt schools. Moreover, the project illustrates that a learning space design is not finished when implemented, but needs to be continuously activated in iterative processes, thus bringing more attention to the processes happening after the implementation of the design. Often, when building new learning spaces, the interaction between the creators and the users of the spaces abruptly ends as soon as the new design has been implemented, which

leaves the users with a spatial design they might not know how to use (Bøjer, 2017). Therefore, I argue that design processes of learning spaces should continue beyond the implementation phase to include a phase of collaborative activation of space in relation to practice. The research project provides knowledge on why and how this activation can be conducted, suggesting co-design as a tool in this process. It is my hope that the knowledge created in this research project will contribute to informing future design projects of learning spaces and that the co-design activities presented in the thesis can serve as inspiration to designers and others working with the design of learning spaces.

Within the framework of Rune Fjord Studio, the research project has contributed with both practical and scientific knowledge on co-design and the design of learning spaces. This knowledge has strengthened the praxis of the agency and created an attention towards more user involvement in design processes as well as provided a basis for a further development of co-design tools in relation to new design projects.

I believe the knowledge produced in this research project to be relevant for decision makers, creators and users of new schools as well as for a broader segment of the public working with design and use of learning environments in post-compulsory education, libraries and even workplaces.

LIMITATIONS OF THE PROJECT

Potential limitations in this study relate in particular to the research design as explained earlier. Due to the unique context of the research project as part of the design praxis at Rune Fjord Studio and the social settings in the schools, it would be difficult to replicate the design experiments in other research projects. However, similar projects could be initiated in other schools; in particular co-design processes resembling the process in school B, as this does not involve a new interior design. Other limitations include a limited sample size (two schools) which is linked to the practice-based approach of the research project with three lengthy design experiments in actual learning environment settings or the fact that experiment #2 was not connected to an actual design process. Furthermore, the design experiments have all been conducted

in Danish schools, which might also be considered a limitation from an international perspective. The Danish perspective was mainly due to the nature and circumstances of the Industrial PhD program, where I was based in a Danish company and therefore did not have time or opportunity to conduct experiments in a different country. Given these limitations, I am reluctant to generalise the findings of the project; however, they do resonate well with existing literature.

I believe that the strength of the research approach—mixing a practice-based design research methodology and methods with qualitative research methods—outweighs these potential limitations. The unique circumstances can also be claimed to constitute the strength of the project, as the research took place in a real context and affected the actual everyday practice of the participants, thereby showing real dilemmas, conflicts and problems. As to the Danish perspective, I have experienced international school buildings projects to be concerned with similar challenges and problems as the Danish projects in regard to matching space and practice and, as such, I believe the findings of this research project to be of relevance outside the borders of Denmark.

There is one area of the research project I particularly would have liked to investigate further. The participatory activation process presented in this thesis was explored as an independent study separated from a design process. I would have liked to explore participatory activation as part of a design process of a new learning space, as this may have added another layer of meaning to the study. An attempt was made in school A to establish a co-design process similar to school B's, but unfortunately this was never brought to life due to a lack of engagement from the teachers. Limitations associated with time and resources in this PhD project made it impossible to conduct a similar investigation in an additional design project.

LOOKING TOWARDS THE FUTURE

In terms of future research, I have already envisaged a new area in learning space research focusing on design processes and design methods in the previous section of this chapter. In the following, I will elaborate on this suggestion and propose further

directions for future research initiatives that could benefit from as well as elaborate on the outcome of this research project.

As this thesis illustrates, participatory processes are complicated as they involve many different stakeholders. Each process, project and group of users is different, which is why it is not possible to develop an all-encompassing toolbox with a set template for a participatory learning space design process. The participatory process has to be adjusted to the specific case and participants (Sanders et al. 2010). Still, I believe that it is possible to develop more detailed knowledge on different types of co-design activities and thus make it more accessible to professionals who are not trained in co-design. The main focus of this project in relation to participatory design processes has been the significance of stakeholder participation in the design process for the following use of the actual learning spaces. A future project could explore the frameworks and design tools involving stakeholders and future users in the design process of new learning spaces. This could even be explored in relation to other educational and cultural institutions such as universities and libraries.

Another research prospect is the notion of participatory activation and its potential in aligning learning space design and pedagogical practice, both in new design projects and in existing learning environments. In this thesis, I argue that many schools today are built with little actual user involvement and with no support in the transition and consolidation phases. To bridge between space and practice, more focus on how to involve the users and activate the spaces is needed. For this, I have proposed ongoing activation of learning spaces, which potentially can happen in many ways and with many different tools. The co-design workshops presented in this paper were not part of an actual design process but took place in an already renovated school, which illustrated the potential of participatory activation in existing built environments. A future project could focus on further exploration of the potential of co-design as a means of transitioning into and appropriating newly built and existing learning spaces. Participatory activation, as suggested in this thesis, is believed to be a dynamic and ongoing collaborative process, because learning spaces are not static designs where one size fits all. Learning spaces keep evolving based on people, pedagogical visions and practices, which is why they have to be continuously unlocked by their users.

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APPENDICES

Appendices can be found at:

http://bit.ly/2IGMMpa

Appendix 1:

The informal interviews in experiment #1 and #3 (extracts from e.g. emails and meeting protocols).

Appendix 2:

Diagram of data collection during experiment #1 and #3.

Appendix 3:

Drawings from experiment #1 and #3.

Appendix 4:

Transcripts of the semi-structured interviews in experiment #2 and #3.

Appendix 5:

Diagram of the findings in the semi-structured interviews in experiment #2 and #3.